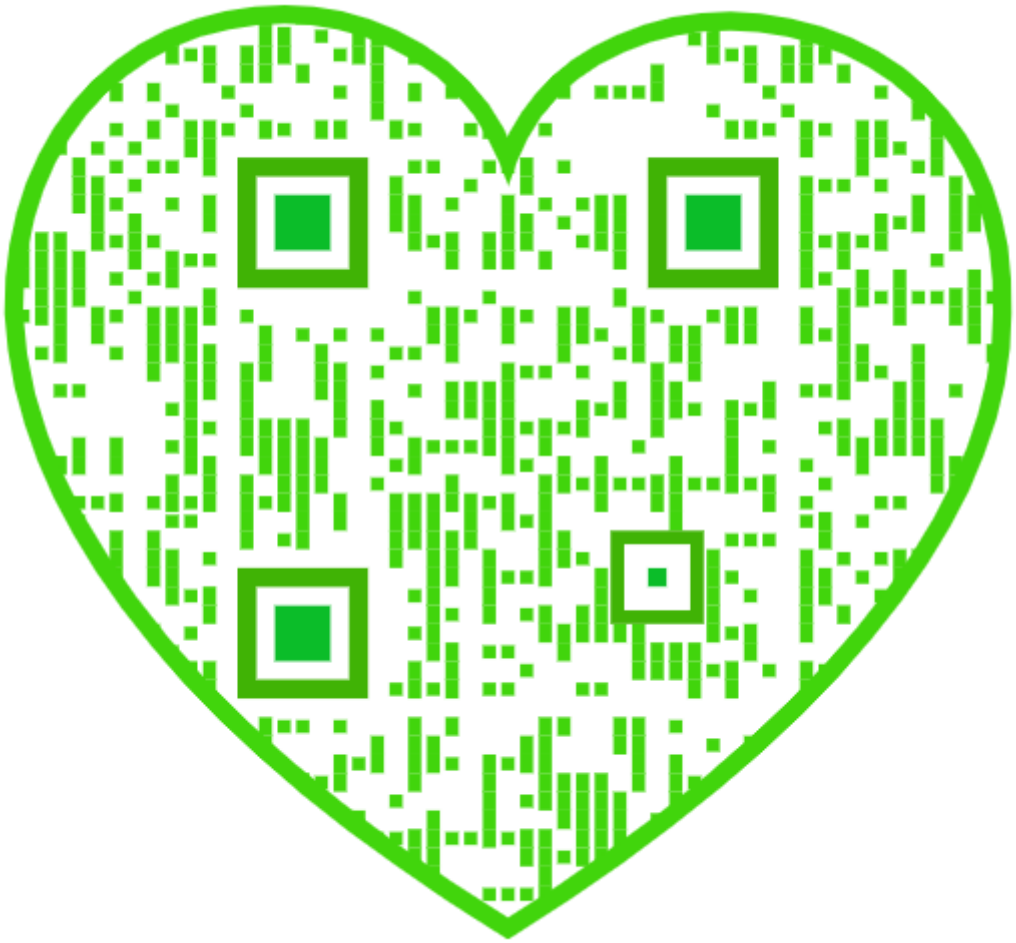

FIRST LESSONS

IN

PRACTICAL BOTANY

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London

MACMILLAN & CO.

1881

191. k. 241.

PREFACE.

THIS book has been prepared because I have felt the need of such a compendium during considerable experience in teaching and examining.

Its aim is to aid students in schools and colleges in the practical work of describing flowering plants. A few short definitions are given at each stage, together with practical directions, which, if followed step by step, will enable the pupil to observe accurately, and to record in writing what he has observed, in proper order and in plain language.

The principal orders of British flowering plants are defined, and some further aid is given in the case of some groups, in order to direct attention to features of importance in describing them.

Woodcut illustrations are not given, for there is much danger that young students will make them substitutes for the objects themselves, or in some way acquire prejudices through their agency.

Orderly descriptions should be written out twice a week, by those who are learning Botany, and corrected by the teacher, during two years of the school course. If this work is faithfully done, students gain a power over their language, as well as over their faculties of observation, which is far beyond even the gain in their knowledge of Botany.

A simple pocket magnifier, a sharp penknife, fine forceps, and pins and needles, are all the apparatus required.

GUY'S HOSPITAL, 1881.

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FIRST LESSONS

IN

PRACTICAL BOTANY.

HOW TO DESCRIBE PLANTS.

LET your descriptions of plants be characterised by

1. Order—that order which is natural and suitable for the purpose.
2. Simplicity of technical terms used.
3. Clearness.

Aim at writing down in about three-quarters of an hour, a clear and full description of a plant when in flower, such as will enable a botanist reading your description, without seeing the specimen, to say what the plant is, or to place it in its proper position among the principal flower-families.

A student who attains this may be certain, not that he knows very much, but that he has acquired a good scientific habit, and is prepared with a practised eye to look upon nature.

CAUTIONS.

Don't cut up your specimen at once, or carelessly pull it to pieces.

Don't make any cuts at all until you have learnt all you can without doing so.

Don't omit to look over the surface of every portion of the specimen with a pocket-lens, as well as with the naked eye; and after making each transverse or longitudinal section, do not forget to examine the surfaces with the lens.

Beware of immediately jumping to conclusions.

Do not use the terms **monocotyledon, dicotyledon,** etc., in your description, unless you are describing a seed in which you can make out the cotyledons.

Don't use in your descriptions the terms **endogen** and **exogen**; they refer to modes of growth, which you cannot trace when you are describing the plant.

Don't describe anything from memory, or any parts you cannot make out in the specimen. Do not **suppose** or **imagine** facts of structure, which you cannot verify. Never "describe" a part not present in the specimen. This is a source of hopeless inaccuracy and confusion of mind.

Do not use terms without clearly understanding their meaning. This often leads to incorrect descriptions, or makes it doubtful in what sense an expression is meant.

HOW TO BEGIN A DESCRIPTION.

At the head of your description give a brief account of the specimen as a whole, as it appears to you.

Ask yourself whether the plant, as you see it, is woody or herbaceous.

Does it belong to a **tree, shrub,** or **undershrub,** or has it grown from seed this season or last season?

Is it in flower or in fruit?

Remember–

1. Most living green leaves you are likely to have in this country live less than one year.
2. Woody branches or stems have mostly lived more than one season, and belong to perennial plants, *i.e.* those which persist through several seasons.
3. They may have new branches every year, which never become woody, but drop off, or die down regularly at the end of their season.

Notice and set down in order the parts of the plant that are present. The principal organs fall into **eight** sections, and if you associate in your minds each number with its corresponding group of organs, you will not easily omit to think of them in proper order.

I shall make each of them the heading of a section in this book; you should make each commence a paragraph in your descriptions.

1. **Root system.**
2. **Stem-and-branch system.**
3. **Leaf-system.**
4. **Inflorescence and floral receptacle.**
5. **Floral envelopes.**
6. **Stamens.**
7. **Pistil and ovules.**
8. **Fruit and seeds.**

I.—Root System.

The root-system consists of **root-fibres** bearing **root-hairs**; with, frequently, a **root-axis.**

It is seldom that you see the whole root-system of any plant.

Root-hairs grow from every new root-fibre, thickly covering its surface.

Their life is short, and they usually become non-absorptive, and brown, and non-adherent to the fibre.

They live fast, absorbing fluid, and growing in consequence; then becoming worn out, and ceasing to absorb.

The number of leaves on a plant gives but a faint indication of the enormous multitude of root-hairs grown upon its root-fibres. They are many millions in number.

The principal part of your description of the root-system must deal with the root-fibres, and where they rise from in the specimen placed before you.

Root-fibres may rise from almost any part of a plant, but especially from—

1. Root-axis.
2. Nodes[1] on stem, and underground branches.
3. Bases of leaf-stalks.

State the apparent abundance of root-fibres on your specimen, and from what part of the surface they proceed.

If you find one principal root-axis, state whether it is slender, or enlarged, swollen and succulent, or woody.

If an underground part of a plant has leaf-buds or "eyes" upon it, this belongs to the "stem-and-branch"

[1] A node is the position of origin of any leaf or leaf-scale upon a stem.

system; but it will probably have root-fibres growing from its under surface.

Make several cross-sections of the main root-axis, if present, and give an account and make a sketch of what you see; and be sure that you distinguish between the knowledge gained by examining the surface and that which you derive from a section of the interior.

Root-fibres, slender at first, may be dilated afterwards, especially in biennial herbaceous plants, which store up cellulose, starch, oil, and other constituents of protoplasm, in portions of root, stem, or stalks of leaves.

CLASSIFICATION OF ROOTS BY FORM.

1. **Tuberous**: a main root-axis dilated in first season in many biennial plants.
2. **Fibrous**: many fibres, without a principal axis; and without much swelling of any fibres.
3. **Tap-root**: when the radicle or primary root lengthens and dilates, forming a prominent root-axis.
4. **Fasciculate**: when there is a bundle of unequally dilated root-fibres.

CLASSIFICATION OF ROOTS BY POSITION.

1. **Primary**: derived from growth of radicle of embryo.
2. **Secondary**: all others developed on a root-axis.
3. **Adventitious**: from stems, leaf-stalks, and leaves.

4. **Aërial**: arising from a part of the plant in air. Some of these never reach the ground.
5. **Parasitic**: entering another plant and becoming adherent organically to its tissues, so as to derive nourishment from its host.

II.—Stem and Branch System.

A.—General Definitions.

The **stem** is the **axis** which bears **lateral members.** The lateral members are borne on a stem which is not necessarily erect or above ground.

The first stem appears from the centre of the first leaf-bud of a plant.

Branches mostly grow out of stems in the angle between the base of a foliage-leaf and the younger part of the stem from which it grows.

This angle is called the **axil** of the leaf.

Most stem-branches are **axillary**; some are not axillary, but are developed outside the axils, and called **extra-axillary.**

Every **bud** consists of lateral members on a short axis in which the spaces between the members (that is, the **internodes**) are very little developed.

B.—External Characters.

First note where the main stem is (usually bearing lateral members and branches), then its consistency, colour, mode of branching, and the nature of its surface.

As to position, stems and branches are found—

(1.) **Erect,** that is, growing vertically, and stout enough to bear the weight of their own leaves and flowers.

(2.) **Ascending,** that is, partially on the ground, and then rising from the ground.

(3.) **Prostrate,** that is, entirely on the ground.

(4.) **Underground,** either wholly or partially.

Stems may be **climbing, clinging, trailing, twining,** wholly **aërial,** or **parasitic** on other plants.

A succulent green stem may have very minute lateral members. In this case the stem fulfils the functions of ordinary foliage-leaves.

The situation on a stem where any lateral member grows out is a **node**; the portion of an axis between two successive nodes is an **internode.**

When the **internodes** are very short, and the stem has remained long in the condition of a bud, describe the axis as **condensed.**

Note (1.) whether the stem is especially enlarged or swollen at the nodes.

(2.) Whether it is ribbed or ridged in any especial manner.

(3.) The relation of the ridges upon it to the leaves and their place of origin.

(4.) The character of its hairs, or, if these are absent, whether the surface is shining, green, brown, etc.

A shoot is the condition of a developed leaf-bud, with its internodes evident, and its lateral members well developed.

A twig is a short lateral branch become woody, after at least one season's growth.

C.—Underground Stems.

The underground stems in Mint, Sedges, and Couch-grass, have long internodes.

They often have lateral members, which are brown and scale-like, not green, and which bear erect branches in their axils.

True underground and woody stems may persist, although the whole of the plant above ground may consist of herbaceous annual branches, bearing lateral members, which die after one season.

Thus the **herbaceous perennial** has an underground stem, which increases yearly in length, having buds in the axil of one or more foliage-leaves. The **persistent** part of the stem may be only short, and but slightly woody.

Sometimes it is a branch rather than the original stem, by which the plant persists; and this produces buds while the stem and its lateral members die. Thus the plant becomes really perennial, by sending out fresh **annual** stems.

Food is mostly stored up to start or strengthen the growth of a biennial in its second season, or a herbaceous perennial in any season.

In all these cases where the leaves do not persist, the reserve food is stored up—

(1.) In the bases of leaf-stalks.

(2.) In the main stem, or in special branches.

(3.) In the main tap-root, or in root-fibres.

A **bulb** is an enlarged organ, in which the axis is flattened, bearing as its lateral members the thick bases of leaves which have already lived, and the bases of future leaves, or true scales.

Bulbs, when annual, mostly develop their inflorescence from the terminal bud.

The potato-plant has an underground branching stem, bearing root-fibres; and the "potato-tuber" itself is a short swollen branch; the "eyes" are its leaf-buds.

Use the word **rhizome** as a general term for an underground stem which is neither a tuber, nor a bulb, nor a corm.

The **rhizome** lengthens at one end, bears leaf-scales, with branches in their axils, and with root-fibres growing from the under surface of the nodes.

D.—STEMS AS ORGANS OF RESERVE.

Corm: chiefly dilated stem.
Bulb: principally leaf-scale, or bases of leaves.
Tuber: dilated ends of branches.

You can often, in examining an unknown bulb, discover its relation to the foliage-leaves and flowering axis.

In some cases the bulbous structure belonging to an axis is formed **before** the green leaves and flowers; in some **after** the flowering of its own axis.

The annual bulb of a tulip, in condition for planting, is a **bud** composed of four or five swollen **scales** enveloping a rudimentary flowering **axis.**

The **outer** scale has a bud in its axil, which becomes perfected during the flowering season, while the old bulb shrinks up.

Corms have less of a sheath or fewer scales outside, than of dilated axis inside. The **Crocus** corm has one terminal bud. **Colchicum** has lateral buds in its corm. There are usually portions of successive years' growths in each plant; but in any case the nutrient and older axis shrivels during the flowering, and the new **corm** develops as a lateral shoot or branch by the agency of food accumulated by the activity of green leaves either of that axis or the preceding one. This accumulation you will find to have been possible because of the direct communication between successive axes.

In stems of biennial plants the internodes are but little developed in the first season, while a store of nutriment is accumulated; in the second season the terminal bud shoots up, forms a flower-bearing stem, and uses up the food store.

E.—Branches.

A **runner** is a branch **above** ground, producing buds and root-fibres like a rhizome; and each bud may become an independent plant.

Branches may be found as **spines** or **tendrils.**

In the Virginia creeper the tendrils are modified branches, expanding at the ends into glutinous suckers, which fix the branches to the support.

In the grape-vine, the spirally-twisted branches twine round a support like a twining-stem.

In describing the branching of a stem, notice whether the branches arise from all the axils, or whether some branches are **regularly** suppressed. Notice also the condition of the terminal buds on stems.

F.—Transverse Sections of Stems.

Make clean transverse sections, or cut very thin slices off the stem in three different positions—

1. Near the base of the flower-bearing axis, if present.
2. At the nodes, where the leaves are attached.
3. At several internodes, if they are perceptible.

Thereby you may ascertain—

(1.) The true outline and shape of the stem in its various parts.

(2.) That the stem is usually solid, and often swollen at the nodes.

(3.) That the youngest stems are always solid.

(4.) That the hollow or fistular condition of many herbaceous stems arises from the growth of the tissue in the circumference, which being thus pulled away from the central tissue, the latter dries up.

In herbaceous plants you will find either that the soft succulent tissue is abundant, forming a central mass of pith, with vascular bundles, cortex, and epidermis outside; or that the pith has ceased to be formed after a certain time.

If the vascular bundles are of the kind termed **open**, that is, if they possess the power of continuous growth in thickness, you will usually find all through the well-developed portion of the axis a concentric arrangement of parts; and the bundles soon become

evident in your sections as points of green or greenish-white tissue, which are the cut ends of these string-like bundles.

When the bundles are of the kind termed **closed** (not capable of increase in thickness), you will not find such an evident circle of bundles, or such a concentric arrangement of parts. In any case, describe what you are able to make out by these sections, and do not describe the stem as "exogenous" or "endogenous." The bundles, when "**closed**," are seen scattered in the pith-like tissue of the stem, unless this is hollow; and there is no true bark.

Woody stems or branches should be described on similar principles to herbaceous stems, by means of transverse sections. State the relative proportion of pith in the centre, and the number of woody rings you can see, if they exist.

Remember that the cambium region, in wood of more than one year's growth (when the bundles are open), is a continuous mass of tissue surrounding the inner (woody) part of all the bundles; while the inner layer of cortex, next to the cambium, is that portion which belongs to the same year's formation as the outermost of the woody rings.

G.—Longitudinal Sections of Stems.

By a careful longitudinal section of the stem, whether herbaceous or woody, you will discover where the hollow part of a stem ends, and how the leaves or flowers are connected with the vascular bundles or with the general tissue of the stem. You will also

see the course of the vascular bundles within the stem.

III.—Leaf-System.

Phyllomes or **lateral members**

1. Originate **below** apex of adjacent growing point.
2. The **nearer** leaves are to the **apex** of the **axis** on which they grow, the **younger** they are.
3. They are external growths on the stem; the surface is continuous; the epidermis is unbroken.
4. No absolute boundary can be made out between stem and leaf.
5. At first leaves grow more rapidly than the stem, and they close over its apex, forming a **bud.**

A.—How to describe Leaves.

In describing foliage-leaves take into account

1. **Position** on the stem or axis (implying nearness to, or distance from ground).
2. Mode of **arrangement** on the axis.

Next give a description applicable to a single leaf, noticing (if any)—

1. **Stipules.**
2. **Petiole** or leaf-stalk.
3. **Blade** or **lamina.**

In describing the **blade,** state whether it is simple or compound.

If **simple,** describe—

1. Shape of blade.

2. Kind of **margin** (entire, or indented, or lobed).
3. The **veins,** and their mode of branching.
4. **Surface** (*i.e.* character of epidermis; differences between upper and under surface; hairs).
5. Consistency and thickness of blade in general.

Notice differences between any of the successive leaves in any of these respects.

In a compound leaf, describe—

1. The petiole (up to origin of first leaflet).
2. Midrib (often called rachis in compound leaves).
3. Mode of attachment and grouping of **leaflets.**

Note the same particulars about the lamina of a leaflet as you would about that of a leaf; also the—

1. Number of leaflets.
2. Similarity or differences of successive leaflets of same leaf.
3. Whether the leaflets are themselves symmetrical about their midveins.
4. Variations in the leaflets of successive leaves.

B.—Contrasted Features.

Petiolate (stalked).
Cauline (on the stem above ground).
Evergreen (lasting more than one season).
Simple (having one blade, with no lobes extending to the midrib).
Sessile (not stalked).
Radical (apparently from surface of ground, or apex of root).
Annual (lasting one season).
Compound (more than one distinct leaflet on a stalk).

Entire (not cut or indented at the margin).
Glabrous (without hairs on the surface, and smooth).
Lobed or **toothed.**
Hairy or **rough.**

VENATION.

A leaf or leaf-blade may have—

One principal vein or midrib.
The branches may **fork** regularly.
Arise at an acute angle, forming an acute-angled network.
Several principal ribs running nearly parallel.
The branches may unite at right angles, forming a square mesh.

C.—COMPOUND LEAVES.

A **pinnate** leaf has more than two distinct leaflets upon one petiole.

Note that a compound leaf may have as few as two leaflets; also it may have two leaflets, and the midrib may end in a tendril.

In a **bipinnate** leaf, each portion arising by a separate stalklet from the general midrib of the leaf has distinct secondary leaflets on the same plan of branching as the leaf as a whole.

A **ternate** leaf has three leaflets proceeding from the same point.

A **palmate** leaf has more than three leaflets attached at the same point to the apex of the leaf-stalk.

In compound leaves the leaflets usually have their own **stalklets.**

Many large bipinnate leaves have their secondary

leaflets deeply cut or lobed; others have them again divided, quite down to the midrib, constituting leaflets of the third rank. When lobes of a higher order occur in leaves, they may be called **finely-divided**; the lobes in these leaves are often very narrow, and described as linear, or oblong.

D.—PRINCIPAL FORMS OF LEAVES.

Cotyledon, leaf developed as part of an embryo-plant in a seed: a seed-leaf.

Scales, brown, or membranous, or fleshy members at the base of stems, or on the outside of buds.

Radical-leaves, foliage-leaves growing at the base of a stem, or forming a tuft on a condensed axis, at the surface of the ground, or arising from an underground stem.

Cauline-leaves, foliage-leaves growing on a stem possessing internodes, and rising above ground.

Phyllode, a leaf-like petiole (with or without blade), usually expanded vertically at right angles to the ordinary plane of a leaf.

Tendrils, slender, usually twining organs of attachment, which may represent branches, stipules, petioles, or the midribs of leaves, or leaflets.

Spines are sometimes modified stipules, or leaves; most frequently branches.

The other principal forms of **phyllomes** or lateral members, are bracts, and parts of the flower.

E.—PRINCIPAL FORMS OF STIPULES.

Stipules, expansions at the junction of leaf with stem, may be

Green, or membranous, attached to the petiole on either side (adnate).

Shaped like leaflets, and distinct from the leaf or petiole, usually a pair at the attachment of the leaf to the stem.

Tendrils, or spines, may represent stipules; that is, they may occur in the position of stipules.

Tubular sheaths, often membranous and brown, extending for some distance above the origin of the leaf, and distinct from its petiole, are of the nature of stipules.

F.—Petiole or Leaf-Stalk.

When the **petiole** is expanded, so as to surround or ensheath the stem, more or less, note this in your description as a **sheathing** petiole.

The leaves of grasses have a long cylindrical leaf-sheath, enveloping the stem, and slit all the way down, on the side opposite to the lamina or leaf-blade.

In the sedges there is a long cylindrical leaf-sheath, which is not slit at all, and consequently called **entire.**

Notice the shape of the petiole in cross-section, also its grooves, angles, and hairs, if present. Many petioles are channelled above, if angular below.

G.—Arrangement of Leaves.

When more than one leaf occurs at a node, the leaves are **whorled.**

Where the whorl consists of two only, the leaves are described as **opposite.**

Where two successive pairs of opposite leaves, if

placed at the same level, would surround the stem with a whorl of four leaves, the successive pairs are **decussate,** or are set exactly crosswise on the stem.

When leaves are set in regular alternations, they often occur in two ranks or rows, each leaf being directly above the last but one, so that the third leaf in succession on a stem is directly above the first. The arrangement of the leaves is then called **two-ranked.**

Another arrangement is when there are three rows, the fourth leaf above the first. When the leaves are thus **three-ranked,** the stems often have three prominent angles.

The arrangement of leaves, beyond the simplest and most constant plans just mentioned, is not of sufficient practical importance for the young student to spend time over.

When the leaves are closely crowded on the stem, they are—

1. **Imbricated,** like tiles.
2. Regularly arranged on a depressed axis **(rosette-like).**
3. Or **tufted** in a bundle **(fasciculate).**

Leaves which are truly decussate sometimes seem not to be so, because the axis is itself twisted, or the stalks of the leaves are twisted. When this is the case, it can usually be traced, and should be noticed.

H.—Classification of Shapes of Leaf-Blades.

A.—Blades of nearly the same width all the way.

Acicular, very narrow, needle-shaped.

Linear, a narrow longish form, in which the two margins are nearly parallel.

Cylindrical, when a linear leaf is thick, succulent, and rounded.

Oblong; this is rather frequently found with the angles more or less rounded.

B.—Blades widest near the Base.

Cordate: heart-shaped, bulging and rounded on either side of the base.

Sagittate: arrow-shaped, with a pointed lobe on either side of the base, and a pointed apex.

Reniform: kidney-shaped, broader than long, rounded on the free side.

Ovate: egg-shaped, rounded at the free end, and broader near the base.

Lanceolate: much longer than broad, and tapering gradually to a pointed apex.

Triangular: with three sharp angles.

Ensiform: spear-like, stiff and long (Iris).

Cuneate: wedge-shaped, with the apex of the leaf representing the narrowed part of the wedge.

C.—Symmetrical rounded forms.

Circular or orbicular.

Elliptical.

Oval.

Peltate: shield-like; a nearly circular form, with the stalk near the middle.

D.—Broadest near Apex.

Obovate: the converse of ovate; broader at the end distant from the base.

Obcordate: the converse of cordate; the apex of the leaf broad, and considerably indented in the middle.

Obcuneate: the converse of wedge-shaped; the base representing the point of the wedge.

A stem becomes **winged** when the leaf-blade on either side of its attachment runs down the stem as a thin ridge; and the leaf-blade is then termed **decurrent.**

When a leaf-blade is unsymmetrical about a median line, mention this in your description. Sometimes the blade does not extend to an equal distance at the base on either side of the midrib; it is then termed **oblique** at the base.

LEAF-APEX.

Some terms are especially applicable to the apex of the leaf, which has its own series of peculiarities.

When the apex has a small and sharp projection noticeable apart from the general contour of the margin, it is **mucronate.**

When the apex has a rather long and narrow continuation of the leaf-blade, it is **acuminate.**

When the leaf is indented at the apex, but not deeply, it is **emarginate.**

I.—The Margin of Leaves.

When the margin is not indented, but presents a perfectly simple and unbroken outline, call it **entire.**

It may be variously waved or **sinuous,** with more or less shallow and rounded indentations.

Sharp teeth in the margin are usually the ends of veins.

Dentate is a general term, when the margin has small sharp lobes.

Leaves with **serrate** (saw-like) margin have fine teeth pointed towards the apex of the leaf.

A **crenate** margin is one with small rounded lobes, in the middle of which a vein ends without projecting, or with very little projection.

Use the term **lobed** for a leaf cut into a number of sections which are more like leaflets than large teeth. If the principal divisions are fewer than ten in number, state the number of lobes.

In lobed leaves, the lobes correspond very naturally with the general plan of the venation.

Thus a leaf which has the margin cut into lobes or segments, after the palmate manner, will usually be found to have one principal vein in each lobe, arising from the midrib near its base, and radiating from it.

So a leaf which is pinnately cut will have its principal veins branching from the midrib in a pinnate manner.

When a leaf is but slightly or not at all indented at the margin, it may have a very definite pattern in the arrangement and branching of its principal veins. Sometimes the principal veins are almost parallel as they rise from the midrib, and straight in their course. In others, the principal veins are always curved ; there is not unfrequently a submarginal curved vein running a curved course just within the margin, and uniting with many others. Thus we find a general character

or appearance belonging to the principal veins of the leaves of a plant.

If you cannot discover any veins, do not write "veins absent." The non-appearance of veins may be due to the thickness of the leaf, or of the epidermis of the leaf, or to the succulence of its tissue. Very rarely there may be no veins, only a midrib; but more frequently when the veins are imperceptible, it is due to thickness of epidermis or of leaf-tissue.

Veins are usually perceptible on the under surface of leaves as distinct ridges or elevations.

J.—Leaf-buds.

If you have leaf-buds of any notable size to examine, look carefully how the leaves inside the scales are packed. Especially look at the young buds of trees as they develop in spring.

When simple leaves have a distinct midrib, the most usual ways of folding in the bud will depend on a folding of the leaf upwards and inwards, along the midrib, so that at first only the under surface of the leaf is seen from the outside. A single leaf may also be folded so as to have the upper surface turned outwards on either side of the midrib, and the under surface concealed.

When this folding of a leaf is perfectly simple and flat, successive leaves may half enfold one another, or each leaf may entirely enfold the next.

The folding may also take place in the manner of a roll, and this roll may be on the upper or under side; or there may be two rolls, one from either side to the midrib.

Similarly, a single leaf may be folded double and flat from apex to base, or in a narrow roll from apex to base.

You will find that a compound leaf often has its single leaflets folded in two flat portions, and the whole leaf folded into two, compactness being much favoured. A single terminal leaflet may be bent down and folded among the other leaflets, and the whole leaf-blade may be folded on its upper or under surface parallel with the leaf-stalk as it grows.

When there are more leaves than one at the same level, the folding in the bud depends upon the number at one level or in one whorl, and the final shape of the leaves.

When the leaves are alternate, or singly placed, the arrangement in the bud depends on the number of rows or ranks of leaves, their shape, and the number in each bud.

Notice the small scales on the outer surface of the bud, and the gradual transitions between these and the fully-developed leaves within the buds.

When the leaf-buds are of considerable size, observe the structure by three methods—

(1.) By making transverse sections at various levels.

(2.) By making vertical sections in several diameters.

(3.) By removing the leaves successively with a penknife blade.

Brussels sprouts, horse-chestnut buds, ash-tree buds, and willow-tree buds, are of good size for examination and description.

TERMS APPLICABLE TO SINGLE LEAVES.

Plane or flat: when not folded at all.

Conduplicate: when folded once on the midrib.

Plicate: when folded in several plaits.

Involute: when each half is folded inwards towards the midrib from the margin.

Revolute: when each margin is folded outwards about the midrib, the under surface being hidden.

Convolute: when there is only a single roll, one margin being inside and the other outside.

Crumpled: when the leaf has no definite folding about any one straight line.

IV.—INFLORESCENCE.

A.—THE AXIS.

The axis which bears a single flower in an inflorescence is its **pedicel.**

The axis which bears several pedicels or sessile flowers is the **peduncle** of the inflorescence.

A **scape** is a radical peduncle, that is, a peduncle springing apparently from the root, or from a condensed axis, and bearing no foliage-leaves.

A pedicel bears a **terminal** flower, when it is the apex of a stem or leafy branch.

A pedicel bears an **axillary** flower when it is in the axil of a bract.

A peduncle bears a terminal inflorescence when it has no foliage-leaves.

The Inflorescence is—

Definite: when the bud at the apex of each floral axis becomes the first flower borne by that axis; and the succeeding flowers terminate branches lower down on the axis.

Indefinite: when the apex of a floral axis does not at once produce a flower, but continues to

grow during the flowering season, producing axillary flowers or floral axes.

B.—PRINCIPAL FORMS OF INFLORESCENCE.

A **spike** has **sessile** flowers arranged along an axis.

A **raceme** has **stalked** flowers arranged along its axis.

A **panicle** has a **branched** axis, the branches bearing **stalked** flowers.

A **corymb** is a panicle in which the pedicels are of different lengths, and the flowers reach one level.

In an **umbel** the branches of the peduncle proceed nearly from one point, and the pedicels radiate from it.

A **capitulum** is borne upon a conical or flat-topped **receptacle**; it bears sessile flowers surrounded by an involucre.

A **cone** is a form of spike with large bracts.

A **spadix** is a thick fleshy axis, bearing many simple flowers.

A **catkin** is a pendent spike, often containing staminate or pistillate flowers only.

C.—BRACTS.

Bracts are modified lateral members, protecting flower-buds before their pedicels have grown, as leaf-scales protect leaf-buds.

Describe as **bracteoles**, minute lateral members, when found on the pedicel, often close under the flower.

An **involucre** is an arrangement of bracts in whorls surrounding peduncles or special kinds of inflorescences, with sessile flowers.

An **involucel** is an arrangement of bracts around the base of a sessile flower in an inflorescence.

Note the shape, size, and texture of bracts; describe them as **leafy** when they resemble the ordinary foliage-leaves; as **membranous** when they contain no green tissue.

D.—Floral Organisation.

Notice—

1. The number and character of flower-leaves and the floral envelopes they form.
2. The number, character, and apparent attachment of stamens.
3. The position, attachment, and external indications, shown by the pistil.

In describing flowers, note down, first, what you can see of the flowers externally in all their stages.

Examine flowers—

1. When the buds first appear.
2. When all the parts are visible.
3. When the flower is open.
4. Also those in which any part of the flower has already fallen.

Make transverse and vertical sections of flowers in each state, if you have a sufficient number of flowers, and compare them with one another.

A **complete** flower has all the parts present.

An **incomplete** flower has some part or parts absent.

A **perfect** flower has all parts present, and fully developed.

An **imperfect** flower has some parts present, but not fully developed.

In some flowers there are single members much reduced in size or efficiency; describe these as **abortive.**

Describe flowers as—

Staminate, if they have stamens, but no pistil, or an imperfect one.

Pistillate, if they have a pistil, but no stamens, or imperfect ones.

Neuter, if both pollen and ovules are absent.

A plant is—

Diclinous, when pollen and ovules occur in distinct flowers.

Monœcious, when staminate and pistillate flowers are found on one plant.

Diœcious, when staminate flowers appear on one plant, and pistillate flowers on another plant of the same species.

In describing the floral envelopes, give, first, an account of the number of different kinds of floral leaves.

Usually there are two, calyx and corolla, outer and inner.

If you find only one kind in the bud, you may find two kinds later on, or the outer may be replaced by an involucre.

The floral envelopes may be—

1. **Bracts,** modified so as to have much of the character of a calyx, but protecting very many small imperfect flowers, as in the daisy.
2. **Calyx,** usually of small green leaves, protecting the whole of the organs within a single flower.
3. **Corolla.**

E.—Floral Receptacle.

The relative position of parts in a flower is best considered with reference to the **receptacle** and its modifications.

The floral **receptacle** is the part of the axis to which the lateral members constituting a single flower are attached.

The receptacle is—

1. Simple and elongated, with all the lateral members separately and successively attached to it (Ranunculus): here the pistil is superior.

2. Laterally extended, with calyx, corolla, and stamens attached to its margin, and also rising as a central boss bearing the carpels (Strawberry).

3. Very concave, with calyx, corolla, and stamens attached to its margin, and a pistil of many carpels seated on its inner surface, somewhat like a Strawberry turned outside in, as in the Wild Rose.

4. Concave and **tubular**; the upper margin closing over the pistil consisting of one or more carpels, sunk in the receptacle, only allowing the style or styles to emerge, bearing the calyx, corolla, and stamens apparently on the top of the ovary. In this case the ovary is said to be **inferior.**

The floral receptacle, or the floral members may present at various parts glands, or lines of glandular tissue. Sometimes these are of considerable size, so as to be termed disks. Notice the position and number of the glands when separate, and the position and size of the disk.

V.—Floral Envelopes.

Since the floral envelopes consist of phyllomes, or modified leaves, notice carefully—

(1.) How far the members of calyx or corolla resemble foliage-leaves.

(2.) Whether there are any resemblances in them to the stamens of the same flower.

(3.) Whether the floral leaves in calyx or corolla arise from the receptacle at the same level **(whorled)**, or are attached in series upon the receptacle **(spiral)**.

(4.) Whether there be more than one set of each kind, that is, a calyx, or a corolla of more than one whorl, or series of leaves.

(5.) Whether the calyx and corolla consist of leaves or members, **distinct** from one another, quite down to their origin from the receptacle, or

(6.) Whether there is some degree of union or **cohesion** between the adjacent parts, or some degree of union between the members of successive series, such as adhesion of corolla to calyx.

When the calyx is constituted of distinct leaves, they are termed **sepals.**

When the calyx consists of parts more or less united, it is **gamosepalous**; its divisions are "lobes" or "teeth."

When the corolla is constituted of distinct leaves, they are termed **petals.**

When the corolla consists of parts more or less united, it is **gamopetalous**; describe its divisions as "lobes" or "teeth."

There are cases in which you find it difficult to be

certain whether the single floral envelope that is present should be called a calyx or a corolla.

The calyx or corolla might have already fallen; but usually there would be some trace of it, in that case.

Where there is a real doubt, use the term **perianth** to denote the floral envelope; describe the members of it, when distinct, as **perianth-leaves,** or segments.

If the segments of the perianth are not distinct down to their attachment, the perianth is **gamophyllous.**

A perianth of six leaves may show signs of division into two whorls of three leaves; and these may differ in form and colour to some extent.

Any such indications of distinction into two series, should be noted; and when the distinctions are not so great that the terms calyx and corolla can fairly be applied, give first the distinguishing characters of the leaves of the outer whorl, and then those of the inner whorl.

A.—Sepals.

When you have determined that the calyx consists of free sepals, and noted the number and relative position of the sepals—

If the number of sepals be **odd,** note whether the odd sepal is

Anterior, that is, on the side of the flower away from the axis on which the flower is borne, or

Posterior, that is, on the side of the flower nearest to the axis.[1]

[1] When the flower ends the axis, this does not apply.

Note whether there is any marked inequality of size or shape among the sepals, and next, whether they form two or more sets.

When the sepals are all similar, describe them in the same way as foliage-leaves are described. The calyx is then regular, and composed of free sepals.

Similarly, when the sepals differ from one another, after mentioning the points in which they agree, set down the special features of particular sepals.

Sepals are described as

Petaloid, when they are brightly coloured (not green).

Membranous, when neither petaloid nor green.

Scaly, when they are small, dry, and thin.

Saccate, when they are dilated at or near the base.

Spurred, when their tissue is prolonged at the base, so as to extend into a tube below the base of attachment.

Divergent, when they spread away from the receptacle and from one another, making something like a right angle with the receptacle.

Reflexed, when they are bent backwards from their origin, and partially hide the pedicel or axis.

In the bud the sepals may be, in relative position—

Imbricated, overlapping one another.

Valvate, touching one another, but not overlapping; or they may not meet.

As regards their continuance relatively to other parts, sepals are

Caducous, when they fall as soon as the flower opens.

Deciduous, when they remain for some time after it opens, and then fall.

Persistent, when they continue after the fertilisation of the ovules, and during the ripening of the seeds.

B.—Gamosepalous Calyx.

The **gamosepalous calyx** rarely consists of a tube showing no partial divisions into lobes or teeth.

Usually you will find teeth or lobes, the number and character of which you should note.

The term "tooth" is used for the division of a calyx when it is acute and sharp-pointed, and shorter than the tube itself. In all cases observe and note the shape of the lobes.

When the tube is of considerable size, and the teeth or lobes nearly equal in size, the undivided portion may be—

Tubular or cylindrical.

Funnel-shaped.

Bell-shaped.

Inflated, sometimes of an ovoid figure.

Angular, and showing ribs which correspond with the midribs of leaves.

When the teeth are so placed, or of such a size, that they are plainly in two sets, the calyx is **two-lipped** or bilabiate.

There may be special dilatations in particular parts of the calyx, or projecting spurs, which should be noticed, as well as the part of the calyx in which they occur.

Often the gamosepalous calyx is persistent during the ripening of the seeds.

C.—Petals.

If the number of petals be **odd,** note whether the odd petal is **anterior** or **posterior.**

Look into the flower to make sure of the position of the petals in relation to the sepals; whether they **alternate** regularly with them, or are opposite to them.

If there be more than one series of petals, note the position of the members of each series, with regard to those without and within.

In the **regular** corolla of free petals, the petals are similar in size and form. Many terms used in describing the petals are the same as those used about leaves.

Many petals will be found to consist of a slender stalk or **claw,** and a blade or **limb,** extending at a right angle from it.

You will also find petals without a claw.

Note the shape of the petals, and any scale-like organs they may present at the base, or at the junction of claw and limb, and spurs or projections which all or some of them may possess.

When the petals differ from one another in any way, mention first the points in which they agree, and secondly, the special features of particular petals.

Petals are described as—

Sepaloid, when they are green and foliaceous.

Membranous, when very delicate and thin, not brightly coloured nor green.

Scaly, when small and thin.

Saccate, when dilated at or near the base.

Spurred, when their tissue is prolonged at the base, so as to form a tube or spur below the attachment.

Divergent, when they spread away from the receptacle and from one another.

Reflexed, when they are bent backwards from their origin.

Petals are—

Seldom **caducous.**

Usually **deciduous**; that is, they remain on the flower for some time after it opens.

Sometimes **persistent,** in a withered condition.

As to relative position in the bud, petals are—

Imbricated, overlapping one another.

Valvate, touching one another, but not overlapping.

Contorted, when the individual petals (when imbricated) are also themselves curved spirally.

Crumpled, when the petals are irregularly crushed together, or being large, are confined in a small space.

Or they may not meet at all.

Sometimes you may find petals in curious curved shapes, conical and hollow; these are usually named **nectaries.**

Sometimes they are reduced to mere filaments, like a claw without a blade.

D.—Gamopetalous Corolla.

The **gamopetalous corolla** is more often destitute of marked divisions or teeth, than is the gamosepalous calyx.

But frequently there are noteworthy characters belonging to—

(1.) The **tube,** or undivided part of the corolla.

(2.) The **throat,** at the junction between the divided and undivided part.

(3.) The **limb,** where the teeth or lobes are manifest.

In regard to the **tube,** notice carefully—

(1.) The position of attachment at the base.

(2.) The relative length of the tube to that of the calyx, and to that of the corolla limb.

(3.) The relative calibre in different parts.

(4.) Any internal growths or projections in the tube.

(5.) The height at which stamens, if inserted in the tube, are attached.

(6.) Colour or texture, especially in contrast with those of the other parts (calyx or corolla).

As to form, the principal varieties are—

(1.) Those in which the tube is nearly uniform all the way, and narrow; this may be termed **cylindrical.**

(2.) Dilated, and then again contracted, so as to have an **ovoid** or a **globular** shape.

(3.) Expanded into a **conical** or **funnel-shaped** figure.

(4.) **Bell-shaped,** where the expansion begins very near the base of attachment.

In the **throat** of the corolla may be found sometimes dilatations for anthers, series of scales, little tongue-like lobes; or there may be special groupings of hairs.

In regard to the lobes or divisions of the gamo-

petalous corolla, when these are regular and equal, there will be little difficulty in describing them.

They may be found acute, lanceolate, or triangular, rounded, or ovate, or emarginate in shape.

Note the position of an odd lobe (anterior or posterior), if the number is odd, wherever possible.

The **rotate** corolla has spreading lobes, and the tube extremely short, just sufficient to hold the lobes together.

The **ligulate** corolla has a slender tube, and the rest of it consists of a strap-shaped portion, like a tube slit, and laid open along one side; often with small teeth at the apex.

When an irregular gamopetalous corolla has its throat widely open it is called **ringent.** Sometimes the throat is closed by a projecting lobe; then it is **masked.**

When the gamopetalous corolla is plainly divided into two principal parts, or regions, one upper and one lower, it is **bilabiate,** or **two-lipped.**

Each lip, with its special features or lobes, must then be described separately.

The upper lip may be divided or undivided; arched and hood-like, or reflexed.

The lower lip may be spreading or closed; it is often three-lobed.

There may be no "upper lip" of a corolla when the "lower lip" is fully developed.

Notice especially the relative position of the anthers to these lobes or lips, and the way in which the lips are folded in the bud.

VI.—STAMENS.

Stamens produce pollen within pollen-sacs.

The pollen-sacs are developed in the **anther,** which is either **sessile** upon the axis of the inflorescence or some part of the receptacle, or attached by a stalk called the **filament.**

Mention the number and place of attachment of the stamens.

Notice (1) whether all the stamens in each flower are usually perfect and ready to shed their pollen at the same period.

(2.) Variations in the structure of stamens in different flowers on the same plant, and in the time or manner at which they shed their pollen.

(3.) Whether the stamens shed pollen before the flower opens; whether the ovules can at that time be discerned in the ovary; and whether pollen is present on the stigmatic surface.

Stamens are **inferior,** when they arise distinctly from the receptacle beneath the pistil.

Stamens are **marginal,** when they grow from a lateral extension of the receptacle.

Stamens may be attached to any part of a gamopetalous corolla, and adhere to it when the latter is removed.

Further description is necessary to indicate the character and position of adhesion.

The stamens, when attached to either calyx or corolla, are held to have the same origin as the calyx or corolla.

Stamens are **superior** when they arise from an extension of the receptacle adherent to the pistil, and reaching to the top of it.

A.—Filaments.

Distinguish (1) between a filament or filaments without an anther, occurring quite usually in some groups **(staminode)**; and (2) an abortive stamen or stamens, when the anther is without pollen, and smaller than the perfect anthers in the same or other flowers of the same species.

As to the filament, notice its thickness, whether it is thicker at the base, or unusually extended or spurred at any part.

Whether very weak at the apex, and whether it is specially coloured, or expanded and petaloid.

Notice the relative length of the filaments of different stamens.

When the filament is absent, the stamen is **sessile.**

Stamens are **monadelphous** when all their filaments are united into a tube extending from the base upwards, of varying height in various cases; but remember that there is always a free or distinct portion of filament bearing the individual anther.

More than one whorl of stamens may be united in a single staminal tube.

In some cases the outer whorl (alternating with the petals) is marked by the anthers having longer filaments than the inner.

Stamens are called **diadelphous** when at least one filament is clearly separable from the common tube;

or when there are two bundles of stamens in a flower.

They are **triadelphous** when the flower has three groups of anthers upon three common filaments.

Polyadelphous stamens exist also, in some cases, where there are four or more common filaments each bearing more than one anther.

When filaments are not united to one another, describe them as—

Filiform, if of moderate length and thread-like.

Capillary, if very slender, so that the anther of necessity droops.

Awl-shaped, if narrower at the top than at the base. The filaments are sometimes **spurred**; or they may bear **scaly** processes.

B.—ANTHERS.

The description of the anthers here given refers only to characters visible with the naked eye, or with a low power of the microscope.

The tissue of the anther between its pollen-bearing lobes is called the **connective.** Notice specially any prolongations it may show between, above, or below the lobes, and the manner of its union with the filament.

When the connective is a direct continuation of the filament, the anther is **basifixed.**

When the filament joins the connective at the back of and at some distance from the base of the anther, the anther is **dorsifixed.**

The dorsifixed anther becomes **versatile,** if the

apex of the filament is very slender, so that the anther is easily movable upon its filament.

In some cases the **anther** is **pendent** from the apex of the filament.

Anthers are usually **two-lobed**, that is, similar halves containing pollen are developed on either side of the connective.

Sometimes they have only **one lobe**; or there may be but one lobe which bears pollen, while the other lobe is abortive, or bears no pollen.

The anther-lobes are mostly **parallel** to one another on either side of the connective.

In some stamens the anther-lobes **diverge** at an acute or obtuse angle from one another.

An anther may have its lobes parallel in the greater part of its length, and they may diverge at either end.

The shape of anthers varies much, from **linear** to **spherical.**

You may find the pollen developed in **crescentic** swellings at the margin of the anther.

Some stamens have curiously curved pollen-bearing lobes, not only long, but also doubled upon themselves in their curving; these are called **sinuate** anthers.

Every distinction in shape or appendages should be noticed.

Just as a foliage-leaf shows distinctions between upper and under surfaces, so an anther often has a **groove** between the lobes on one surface. This is most usually on the side turned towards the middle of the flower, and this is called the **face** of the anther.

Each lobe may be described as having a side edge,

a face, and a back; or, to use another set of terms, a lateral edge, an inner and an outer aspect. These terms are necessary because of the variations found in the position of the openings by which the anthers discharge their pollen.

The position and form of the openings by which the anthers open to allow the pollen to escape must be noted.

In most cases the form of the opening is that of a single **slit** or **line** extending along each anther-lobe.

The position of the opening can usually be perceived before the flower has opened, as a groove. When the pollen has been shed, it is much less easy to understand the mode of opening. The anther may become covered with the pollen-dust; its shape changes by reason of the space no longer occupied by the pollen, or it shrivels very considerably. Sometimes even the anther-lobes have a different direction after pollen-shedding.

While the pollen is maturing, the anther looks full and moist. If some of the pollen has been shed, a little will be visible along the line of an opening. In some flowers the pollen is discharged before the flower opens.

In a stamen that is not sessile the anther grows in the bud, before the filament is produced. The anther may be of full size before the filament is noticeable.

Filaments sometimes grow very fast and long, so as to push the anthers beyond the rest of the flower, they are then said to be **exserted**. When this rapid growth takes place with a heavy anther, it causes the anthers to be pendent outside the flower.

Three circumstances may influence the height to which anthers rise in the flower; (1) the number of whorls of anthers; (2) the position of origin of the filaments; (3) the length of the filaments.

When the whorls are more than one, the inner stamens often have shorter filaments; they may also open at a later period.

Anthers may open one at a time, or even the individual anthers may only discharge their pollen gradually.

The position of the longitudinal slit in an anther-lobe may be, in accordance with the terms given—

(1.) On the **inner** aspect or face.

(2.) **Lateral,** just at the edge.

(3.) On the **outer** aspect, or towards the outer part of the flower.

The anther-lobes open by a **curved** slit in some stamens.

By small openings called **pores** in others.

And by the raising of little pieces or flaps called **valves** in others.

In the grouping of anthers in the same flower there are one or two noteworthy points.

(1.) You may find anthers so closely combined to form a tube that you cannot separate them without tearing the connective; describe these anthers as **coherent.**

(2.) The group of anthers may from the outside look like a **cone,** or like a cylinder.

(3.) Some anthers are only so far united that they can be easily separated without tearing the tissues. Describe them as **connate.**

When anthers cohere in a tube, first notice what you see externally, and then the internal characters, after making a slit down the tube to lay it open.

In these, notice especially the mode of pollen-shedding, whether the anthers open inwardly (within the tube) or outwardly; also, whether there are special appendages above or below the tube; and whether the anther-tube is so narrow that the style in its growth must needs receive a deposit of pollen upon it.

Pollen. Notice whether the pollen is in the form of fine powder when shed, or in small masses called **pollinia.**

If there be pollinia, or definite groups of pollen-grains, notice particularly their number in each anther-lobe, and their form.

VII.—PISTIL AND OVULES.

The description of the **pistil** is to include—

(1.) The character of the pistil, as to position, number, and cohesion of carpels.

(2.) The description of ovary, style, and stigma (*a*) by external aspect; (*b*) by transverse sections; (*c*) by vertical median sections.

(3.) Character and number of ovules, and their attachment.

The pistil consists of one or more carpels, bearing one or more ovules.

The principal parts of a carpel are—

The **ovary,** the cavity within which the **ovules** grow and develop.

The **style,** the channel or region by which the pollen-tubes reach the ovary to fertilise the ovules.

The **stigma,** a region not covered by epidermis, becoming moist when ready to receive pollen-grains.

Think of single carpels as leaf-blades having a mid-rib or dorsal suture turned outwards, and the two halves of the leaf-blade meeting and enclosing a cavity, the **ovary.**

The line of meeting is the **ventral** suture.

The ventral suture is turned towards the centre of the flower.

A row of ovules may grow on each of the margins, which together constitute the ventral suture.

The style is usually an upper prolongation of the carpel, and contains no ovules.

At the apex of the carpel is the stigma (in most cases).

A single flower may have a pistil consisting of one carpel only; and this may contain but one ovule.

In a pistil in which there are more carpels than one, quite distinct from one another, especially notice the position of the carpels in regard to the receptacle.

There are three other principal forms or conditions of the pistil when there are more carpels than one—

(1.) When two or more carpels are conjoined, so that their adjacent portions form a common partition or septum (as in the orange).

(2.) When the carpels combine to form one common cavity or joint ovary and there are no partitions; the carpels stand edge to edge, and form a circular enclosure; the ovules grow inwards on the adjacent edges of the carpels.

(3.) When the partitions, if they exist early in the development of the pistil, become entirely lost during

growth, and the ovules are attached centrally to a mass of tissue in the base of the ovary (free central attachment). In this case the wall and summit of the pistil are quite detached from the ovules.

A.—External Examination.

In describing the pistil, carefully note from what source the facts you mention are derived, whether from external view, from transverse sections, or from vertical sections.

In an external view you may learn whether the pistil is superior, inferior, or more or less surrounded by an expanded receptacle.

In the preceding examination of the flower, this may have already become evident.

The species may be **diclinous**; in that case you have either **staminate** or **pistillate** flowers separately to deal with.

In order to determine whether the pistil is "superior" or "inferior" in a pistillate flower, look for the perianth, or traces of it. There may be merely scaly leaves representing calyx and corolla, or there may be only bracts.

Bracts, if present, will be beneath the pistil, not above it. If there are leafy lobes on the top of the pistil, distinct from the style and stigma, they probably represent a superior perianth, and consequently the pistil will be inferior.

If there are no such indications of a superior perianth, the pistil is most likely a free superior one.

After determining the **position** of the pistil, notice all you can of its external characters.

Look for any signs of divisions or lobes; and note in what parts these are evident.

Carpels may be united in the region of their ovaries, and may have distinct styles and stigmas.

They may be conjoined only half-way, in the region of the ovary. In fact, all degrees of union occur between their several parts.

The styles are found united to a very different extent in different species.

The whole stigmatic region representing several carpels may be extremely small, making it impossible to discover without a microscope that it belongs to several carpels.

Grooves upon the style, or protrusions, or lobes on the surface of the ovary, may be noted; sometimes these indicate the number of carpels.

Thus, on an external view, we may distinguish positively how many carpels are present, only when the carpels are all distinct and separate; but when the pistil consists of a single mass, there is no perfect means of distinguishing the number of carpels by external observation.

When the pistil is inferior, it is so engirt by the receptacle as to become truly compounded with it. Sometimes lobes or grooves may be seen on the outside of this receptacular envelope; but this is not sufficient evidence for determining the number of carpels in the pistil.

Consequently it is by transverse sections that we should seek to determine the number of carpels in a flower with a compound pistil.

Other matters to be noted about the pistil are—

(1.) Form and shape.

(2.) Colour, and presence or absence of hairs.

(3.) Relative size of parts to one another, and to the other parts of the flower.

The pistil, or a single carpel, may be linear, or may possess ridges, may be compressed or depressed, may be ovoid, oblong, globular, etc.

Frequently these terms are applicable especially to the ovary, and should be restricted definitely to the part intended.

In some cases glandular projections or channels may be observed on or near the pistil.

Notice particularly the character of the hairs covering the ovary.

B.—Description of the Style.

The number and position of origin of the styles should be correctly stated. In a single carpel you may find the style

(1.) **Apical,** at the summit, apex, or natural termination of the carpel.

(2.) **Lateral,** arising from one side, on the ventral suture (when the ovary and its contents have grown more rapidly than the style).

(3.) **Basal,** appearing to arise even from the base of a carpel.

When there are several carpels in the pistil, the styles may be conjoined in any degree, or may be separate in their whole length.

The length of the styles also varies greatly in different plants, and in some species, in different flowers.

Notice especially the difference between the length

of the styles in unopened and in opened flowers. The styles often grow greatly in length in the interval between their formation and full maturity.

Look for cases in which this growth of the style necessarily carries it past the anthers, so as to ensure (or in some cases to prevent) fertilisation by pollen of the same flower.

C.—Description of Stigma.

Since fertilisation cannot take place unless pollen is placed upon or is caught by the stigmatic lobes, their form and situation must be particularly looked at.

Stigmas are **sessile** when there is no style.

A sessile stigma may be line-like or linear, and be situated on the surface of a carpel.

The sessile stigma may also be restricted to a small region at the apex of a carpel.

Observe whether there is any correspondence between the number, situation, and length of stigmatic surfaces, and the number and situation of ovules in the ovary.

D.—Transverse Sections of Ovary.

By making a series of transverse sections of the ovary with a sharp penknife or dissecting knife, **beginning from the top,** and examining each section with a lens, as well as the portion of ovary left behind, you may determine the following points :—

(1.) Whether there are any partitions in the ovary, and the number of cavities or loculi into which it is divided.

(2.) The position in which the ovule or ovules are attached.

(3.) The number of rows of ovules in the ovary.

(4.) Whether the floral axis is prolonged in the centre of the ovary.

(5.) Whether such prolongation extends to the top of the cavity.

(6.) The thickness and consistency of the walls of the ovary.

(7.) The position and number of the vascular bundles in the wall.

E.—Vertical Sections of Ovary.

By making vertical sections through the ovary from the base upwards to the style you may, in the case of a single carpel, gain—

(1.) A view of the interior of the carpel.

(2.) A view of the number, character, and attachment of the ovules.

(3.) The mode in which the style is connected with the ovary.

When there is a compound pistil with no partitions, a vertical section shows—

(1.) The interior of the ovary.

(2.) The attachment and number of ovules.

(3.) A section through the axial region shows the connection of the pistil with the axis or receptacle.

When there is a compound pistil with partitions, a vertical section may show a face view of the partitions, and the position of the ovules in relation to them.

The section may be so carried up as to show the relation of the styles and the lobes or divisions of the stigma to the cavities of the carpels.

F.—Position of Ovules.

The pistil consisting of one carpel may have but one ovule in its ovary, and this ovule may be either—

(1.) **Erect,** attached to the base of the ovary.

(2.) **Ascending,** attached to the lower lateral part.

(3.) **Suspended,** attached to the upper lateral part, and hanging downwards into the cavity.

(4.) **Pendulous,** hanging from the apex.

The same terms should be used in describing the attachment of ovules when there are more ovules than one in a cavity; but another term is also needed; ovules may be **horizontal,** especially in the middle of a row of ovules, the upper of which ascend, and the lower descend.

When there are two or more ovules in a carpel, they may be in pairs on the ventral suture of the carpel. State the number if not more than six.

In another case you find the ovary having a single cavity, and many ovules attached to a central column, free from the top of the ovary. This is called a "**free central**" attachment of ovules. You must not conclude that the pistil is composed of one carpel only.

Do not describe a pistil as "syncarpellary," unless you have some certain evidence to prove it, rather describe it as "**undivided**" if there are no partitions within the ovary.

In another case, you may find an ovary with more than one ovule, and the ovules attached, in double series, to two, three, or more ridges on the wall of the cavity.

In this condition of the ovary you have sufficient

evidence to show that the pistil is compounded of more carpels than one.

If you find these ridges projecting partially into the cavity, the ovules may sometimes be seen attached all over the imperfect partitions. Note the height of such partitions, and how near they approach to the centre, and the number of rows of ovules, if in rows.

Again, if an ovary has but one cavity, there may be numerous ovules, covering almost the entire inner surface of the ovary.

When the ovary is truly inferior, it is usually compound, and then has more than one row of ovules, the ovules being attached in double series to an axile ridge representing the ventral suture, in the inner angle of each carpel. In this case the pistil consists of more than one carpel. Each partition belongs in part to one carpel, in part to the adjacent carpel, in its entire height and extent.

Similarly the condition in which the ovules are in rows on the walls of the ovary, and there are no partitions, is to be found in inferior ovaries as well as in those that are superior.

G.—OVULES.

The structure and growth of ovules is a matter of microscopic study. If there is anything unusual about the shape or size of ovules, note it. A few particulars about ovules are given here to prepare for what must be said later about seeds, for the ovule is the rudiment of the seed.

All ovules possess a **nucleus** or central mass of

tissue, in which the embryo-plant is formed at a later period.

The integument or **skin** of the ovule begins to grow **later** than the nucleus, and surrounds it, leaving only a minute opening like a pinhole, by which the pollen-tube can enter, to fertilise the germ-cell, out of which the embryo-plant is produced.

The ovules of many species of plants have two skins, one growing after the other; but their growth stops in the same spot, forming the **mouth** of the ovule.

Many ovules become **stalked** as they grow, others remain **sessile** or unstalked.

In the **straight** ovule, the **mouth** is at the opposite end of the ovule to the attachment; the apex of the nucleus is the same as that of the ovule.

In the **inverted** ovule, all parts are reversed, and on one side of the ovule there is a projecting ridge or **seam**, caused by the stalk growing adherent to the ovule; then the **mouth** is near to the attachment of the ovule. The nucleus remains straight, but its axis is reversed.

In the **curved** ovule, the nucleus is bent, and the **mouth** is near the base of the ovule; but there is no **seam**.

VIII.—Fruit and Seeds.

Under this head include a reference to all parts that persist, or show a change after the fertilisation of the ovules.

The **fruit** consists of an envelope or **pericarp** containing a seed or **seeds**.

The fruit may be dry, or succulent; or may have several layers, differing in nature and consistency, which did not exist before the ovules were fertilised.

Note whether the fruit has fewer seeds than the ovary from which it arose had ovules (if you have both flowers and fruit).

When the ovary has more than one cavity, note whether the growth of some of the seeds makes the fruit contain fewer cavities than the ovary did; or whether only one cavity has seeds.

In pistils having free carpels, notice what number of carpels have ripened seed. Often they are much fewer than the original number of carpels; and some carpels may have commenced to develop, and then failed to ripen, owing to the competition of carpels fertilised earlier, or more favoured in structure, position, or opportunities.

Note—

1. Parts which fall off during ripening.
2. Those which wither and remain on the ripe fruit.
3. Those which grow larger and persist.

Among the first may be—

(1.) The corolla and calyx.

(2.) The filaments and anthers, which often wither soon after the discharge of their pollen.

(3.) Style and stigma.

Among the second may be noticed especially the filaments, which often persist after the anthers have fallen off. They might now and then be mistaken for dried styles; but not if carefully followed to their attachment, and compared with the flower from which they proceed.

Among the third we find chiefly the calyx and the receptacle, together with the pericarp.

When the fruit is the product of an inferior pistil, frequently its structure is very similar to that of a superior pistil; the chief difference is that the receptacle forms part of its wall. It is not necessary to give distinct names to inferior fruits.

When the receptacle itself, as distinct from the carpels, becomes much enlarged, or succulent, you find a compound fruit, as in the pome, the strawberry, or the rose. Here the receptacle encloses or bears the distinct carpels produced by one flower. Such fruits are best termed **receptacular** fruits.

A yet more complex condition is when the flat or convex receptacle of an inflorescence of sessile flowers remains, becomes succulent, and encloses the individual fruits, as in the fig. This is a **compound receptacular** fruit.

Some dry fruits containing only one or two seeds have the pericarp extended into **wings,** to cause their dispersal by the wind; otherwise they differ little from single or double achenes.

A.—Principal Forms of Fruits.

Achene—

Dry but not woody.
Produced from one carpel.
Single-seeded.
Pericarp consisting of wall of carpel.
Not opening.

Follicle—

Dry but not woody.

Produced from one carpel.
More than one seed.
Seeds in two rows usually; on ventral suture.
Pericarp consisting of wall of carpel.
Opening by ventral suture.

Legume (POD)—
Dry, rarely woody.
Product of one carpel.
Mostly more than one seed.
Seeds in two rows usually; on ventral suture.
Pericarp consisting of wall of carpel.
Dividing into two valves, at ventral and dorsal sutures.

Siliqua—
Dry.
Product of two carpels.
Seeds usually numerous.
Attached in two sets, on either side of a median partition, which makes the fruit two-celled.
The walls of the fruit separate from the partition, constituting two valves, and leaving the seeds attached on either side to the partition.

Silicle—
Short and broad form of siliqua (see Cruciferæ, p. 75).

Nut—
Dry, woody.
Product of one or more carpels.
Usually one-seeded, developing only one ovule.
Not opening.

Capsule—

Dry.
Product of more than one combined carpel.
With or without partitions.
Seeds, more than one.
Opens by valves, or by teeth, or by a lid, or by pores.

Drupe—

Succulent, with inner hard layer (endocarp).
Of one carpel.
One-seeded.
Not opening.

Berry—

Succulent.
Of one or more carpels.
One or more hard seeds to each carpel.
Not opening.

Pome—

A succulent receptacular fruit.
Of more than one carpel, each distinct.
Each carpel one or more seeded.
Not opening.
Wall of carpel dry, coriaceous, or bony.
Carpels closely enveloped by succulent receptacle.

Cone—

A dry fruit produced from an inflorescence of pistillate flowers.
One or two seeds produced by each flower.
Woody scales cover the seeds, one to each flower.
Scales separate to let seeds fall out when ripe.

The strawberry has a succulent receptacular fruit, belonging to one flower, and bearing upon the convex surface of the receptacle a large number of achenes.

The blackberry and raspberry have fruits composed of a number of small drupes, seated upon a non-succulent but elongated receptacle.

B.—Discharge of Seeds.

The modes by which dry fruits discharge their seeds are conveniently summed up under two heads :—

1. Where the carpels do not open, but, when there is more than one carpel in a fruit, merely separate whole from one another.

2. Where the individual carpels open, either when the carpels do not separate, or when they do separate from one another.

Capsules furnish some of the chief varieties. You will find in some capsular fruits that the partitions between the carpels become split, so that the fruit is split up into carpels, each of which may open dorsally (on the outer wall) or ventrally (towards the axis).

In other capsules the partitions are torn away from the outer wall of the carpel, and the seeds remain on this more central part of the fruit.

Again, without the partitions being split, or breaking away, the dorsal suture of each carpel may open to discharge the seeds.

In the case of capsules which have no partitions, when the seeds are on the outer wall of the capsule, the splitting may be along the dorsal or the ventral

sutures, or along both. You will distinguish the various cases, by finding seeds along ventral sutures, and not along dorsal sutures. In the Wallflower, the splitting is along the ventral sutures, but the seeds are left upon the median partition.

When the capsule only opens part of the distance along these sutures, the capsule is said to open by teeth instead of valves.

Thus, in a capsule you may find as many, or twice as many teeth or valves as there are carpels forming the pistil. Capsules often open by teeth when the seeds are upon a central basal axis, free from the roof of the capsule.

Some capsules have special modes of opening; as when the upper part of the capsule separates and comes off like the lid of a box; or where small holes or pores open in the walls to discharge the seeds.

C.—The Seed.

Many seeds can only be studied microscopically; but in large seeds some points of structure can easily be observed; such as—

1. The texture, external markings, and thickness of the outer coat or **skin** of the seed.

2. The point of attachment of the seed, usually shown by a **scar.**

3. The thickened line of the **seam,** where the seed is developed from an inverted ovule.

4. The presence or absence of embryonic food or **endosperm,** surrounding the embryo.

5. When endosperm is present, the position of the **embryo** and its relative size.

6. The nature of the endosperm, whether floury, oily, horny, etc.

7. The number and character of the **cotyledons**, or first leaves of the embryo; whether they are thick and fleshy, or thin and small, etc.

8. The direction of the **radicle** or primary root of the embryo.

9. The general shape of the embryo, whether straight, or curved, or folded.

10. The shape of the cotyledons on both surfaces when they are large; and whether the cotyledons are themselves folded.

The **skin** of the seed may vary from extreme delicacy to great hardness and considerable thickness; it may be pulpy. Notice any ridges, grooves, or tubercles upon it; they are often in special patterns. The skin is sometimes produced into wings to aid in dispersal; it may have in particular parts, or all over it, longer or shorter hairs.

IX.—THE FLORAL DIAGRAM.

Draw the **floral diagram** of every flower you describe; giving those particulars which are most important in comparing flowers of different groups. By no other method can you become so accurate in your study of flowers.

In the floral diagram you can show the number, relative position, and union or distinctness, of all the members of the flower.

A lead pencil is the most convenient thing with which to draw the diagram.

If coloured pencils are used, with distinct colours for each of the kinds of floral members, there is some advantage; but this can be gained by placing on the drawing such letters of reference as may be needed; viz.—**Ca** for calyx, **Co** for corolla, **Pe** for perianth, **St** for stamens, and **Pi** for pistil.

Be careful to make the diagram large enough, and the lines thin and clear. A clear diagram should occupy half the space of a page of this book. Do not let a fear that you cannot draw well enough hinder you from making diagrams of flowers. If you cannot draw a curve, you can, at least, rule a straight line, or make dots; and these will serve some of the botanical purposes of a diagram.

In a floral diagram you should draw really a **plan** of the flower, on one level, that may be compared to the ground-plan of a furnished room, showing in which walls of the room, windows, doors, fireplace, etc., are; and within these, the position of chairs, tables, etc.

First seek to fix the anterior and posterior parts of the flower, like the north and south on a map. Unless the flower is solitary on its stalk, you can show by a thick dot the position of the axis of the inflorescence at the upper part of your diagram.

If the flower has a single bract at the base of its stalk, indicate this by a curved line (nearly horizontal) at the lower part of your diagram; this is the **anterior** part of the flower. The whole flower may now be mapped in, **within** these two points.

Failing these marks, if there be five sepals, or five lobes of the calyx, the odd one is usually

posterior; and this will give you a definite mark of position.

When the number of members in the flower is small, they can easily be shown as lying on a series of circles, one within another.

Let these circles first be drawn faintly. When the calyx is gamosepalous, thicken the circle in the proper places to show where the lobes are.

If there are free sepals, show this by short lines across the circle. Where the sepals or lobes overlap in the bud, show this by producing the lines representing the sepals, to show this overlapping.

It will be easy, when the sepals and petals are placed on a spiral, to draw a spiral curve instead of circles, and show where the distinct members are situated.

Be very careful to show the petals (or the corolla-lobes, where the corolla is gamopetalous) in their proper alternation with the sepals or calyx-lobes. It is useful to show the existence of a spur or other peculiarity by a loop on the inner or outer side of the sepal or petal.

When the petals have the stamens adhering to them, show this by a line to connect the circles.

Many features of the stamen may be shown in a diagram. Of these, their relative position to the petals, the number of anther-lobes, and the region of their outer wall, where they open to discharge the pollen, are the most important. Two small ovals side by side will indicate an ordinary stamen with two anther-lobes, and a mark crossing this, on the inner or the outer face of the lobe, or on its side, will show that the anther opens inwardly, outwardly, or laterally.

When the pistil is composed of many distinct carpels, make sure whether they are in whorls, or in spiral succession, and then place them in their true position in the diagram.

The dorsal edge of a carpel is towards the outer part of the flower; the ventral edge is towards the inner part, or centre of the flower. Show the ovules by little loops, in the position in which you find them attached; and if they are placed in distinct rows, make as many loops as you find rows.

When the pistil has united carpels with partitions between them, draw the partitions in the position in which you find them, like radii of a circle; and be careful how you place them with regard to the anterior and posterior parts of the flower.

When there are no partitions, you have to show the ovules in the ovary, either on the wall, or on a central axis in the cavity.

If you place in your diagram only what you can clearly make out, and omit anything doubtful, you will follow the best course.

It is possible to show, in a drawing of a vertical section of a flower, features which cannot be indicated in a diagram; and drawings side by side with a description are all useful. But nothing gives such important aid in the study of flowers as learning to make floral diagrams on the plan which has been explained above.

X.—Special Definitions in Modern Terminology.

Phyllome, a general term including all distinct lateral members borne upon stems or branches.

Caulome, a general term including all parts of a plant that bear distinct lateral members.

Cotyledons, the first-developed phyllomes found in the seed.

Andrœcium, the stamens of a single flower when considered collectively.

Gynœcium, the pistil or entire collection of carpels in a flower, taken collectively.

Gymnospermous, bearing ovules not covered or completely enclosed by carpels.

Angiospermous, bearing ovules enclosed or covered by carpels.

Embryo-plant, young plant contained within a seed, after the fertilisation of the germ-cell, up to the time of the development of green leaves in germination.

Radicle, the first root-axis in an embryo-plant.

Plumule, the first bud in an embryo-plant, seen between the two cotyledons, or alternating with the single cotyledon.

Trichome, a general term for all organs developed by emergence from single cells of the epidermis.

Monocarpic, producing seed but once, and dying after one flowering season.

Monocarpic Annuals, producing seed in the season in which the seed is sown, and dying after one season.

Monocarpic Biennials, producing seed in their second season, and then dying.

Appendicular, applied to the lateral members borne on the axes, of which they are appendages.

Ramification, the mode of branching of stems, including reference to the number, direction, closeness, and persistence of branches, producing the general form or aspect of the stem and branch system.

Pseudo-bulb, a term given to dilated aërial stem-branches, swollen with reserve material, often seen in orchids when not fixed to the ground.

Prefoliation, a term used to denote the condition of leaves in the leaf-bud before its expansion, including the mode of folding of single leaves, and the position of leaves in relation to one another in buds; the mode of packing and the number and character of scales covering the bud. This term is used as equivalent to **vernation,** and is more useful because clearly expressive of the meaning, and because it corresponds with the next term "prefloration."

Prefloration, the condition of the floral members in the flower-bud before the expansion of the flower; equivalent to "æstivation."

XI.—Brief Characters of Principal Orders.

Ranunculaceæ—

Flowers with free sepals and petals.

Stamens indefinite, attached distinctly to the receptacle.

Pistil superior, of separate carpels (usually more than one).

Fruit, achenes or follicles.

Cruciferæ—

Flowers with four free sepals and four free petals.

Stamens, six, two lateral shorter; all attached distinctly to the receptacle.

Pistil, superior, of two united carpels.

Ovules, numerous, in two double rows.

Fruit dry; a siliqua or silicle.
Seeds attached to edges of a septum, from which two valves usually separate.

Caryophyllaceæ—
Stems thickened at the nodes.
Leaves opposite, entire.
Inflorescence definite.
Flowers with four or five petals with claws, attached to receptacle.
Stamens distinct, not more than ten.
Pistil superior, one-celled.
Ovules numerous, on a free central column.
Fruit dry; a capsule, opening by valves (not more than ten).

Leguminosæ (section **Papilionaceæ**)—
Leaves mostly compound and stipulate.
Corolla papilionaceous, bilaterally symmetrical, posterior petal outside in the bud.
Stamens ten (nine or ten filaments springing from a special staminal tube).
Pistil superior, of one carpel.
Fruit dry when ripe; a **legume** opening along both sutures, or a **lomentum** (breaking up into portions containing one seed).

Rosaceæ—
Leaves mostly stipulate.
Receptacle laterally extended.
Petals distinct, on margin of receptacle.
Stamens distinct, attached to margin of receptacle, and usually indefinite.

Pistil, of one or more distinct carpels upon or within the receptacle.

Seeds containing cotyledons without endosperm.

Umbelliferæ—

Stems usually fistular (except at the nodes).

Leaves mostly compound with sheathing stalks.

Flowers in umbels.

Petals, five, free, arising from edge of disk above the ovary.

Stamens, five, superior, filaments incurved in the bud.

Pistil of two inferior carpels.

Ovules, one in each carpel.

Fruit dry, carpels separating from axis, and not opening.

Compositæ—

Flowers sessile in dense heads upon an enlarged common receptacle, surrounded by an involucre.

Corolla superior, gamopetalous, tubular or ligulate.

Stamens, five; filaments free upon the corolla; anthers cohering into a tube.

Pistil inferior, ovule one.

Fruit dry, not opening, often having a hairy pappus.

Solanaceæ—

Flowers often on extra-axillary peduncles.

Calyx gamosepalous, five-lobed.

Corolla gamopetalous, regular, five-lobed.

Stamens, five, on the corolla, often with coherent anthers.
Pistil superior, two-celled (usually).
Ovules numerous, axile.
Fruit, usually succulent.

Boraginaceæ—
Leaves and **stems** with bristly hairs.
Inflorescence definite, mostly many-flowered on curved axes.
Calyx gamosepalous, five-lobed.
Corolla gamopetalous, regular, five-lobed.
Stamens five, on the corolla.
Pistil superior, of two conjoined carpels, each two-lobed; **style,** one, basal.
Ovules, four, one in each lobe.
Fruit, four nutlets, seeds without endosperm.

Scrophulariaceæ—
Corolla gamopetalous, irregular.
Stamens on the corolla, usually four, two longer and two shorter; sometimes two only.
Pistil superior, of two conjoined carpels.
Ovules, many in each carpel, axile attachment.

Labiatæ—
Stems square in section.
Leaves opposite.
Flowers in opposite cymes; pedicels short or none.
Calyx gamosepalous, inferior.
Corolla gamopetalous, usually two-lipped (bilabiate).
Stamens, on the corolla, four, two longer.

Pistil superior, of two conjoined carpels, each two-lobed; style one, basal, bifid.
Ovules, four, one in each lobe.
Fruit, four nutlets, each one-seeded; seed chiefly consisting of the embryo.

Primulaceæ—
Corolla, gamopetalous, regular.
Stamens, five, in the corolla-tube opposite to the lobes.
Pistil, superior, one-celled.
Ovules, many, central attachment, free from roof of ovary.
Fruit dry, opening by a lid or by valves.

Amentaceæ—(including the three following orders).
Staminate flowers in deciduous spikes (catkins).
Pistillate flowers, often in deciduous spikes (catkins).

Betulaceæ—(Birches and Alders)—
Flowers of both kinds in catkins, on the same tree (monœcious).
Pistillate flowers, two or three under each bract, attached to a many-flowered pendent axis; no perianth.
Pistil of two carpels, each with one ovule.
Fruit, mostly winged, dry, one-celled, one-seeded.

Salicaceæ—(Willows and Poplars)—
Dicœcious. Both kinds of flowers in catkins.
Fruit one-celled, dry, opening into two valves.
Seeds numerous, covered with silky hairs.

Cupuliferæ—(Oak, Hazel, Beech).
Flowers of both kinds on one tree (monœcious).
Pistillate flowers surrounded by an involucre.
Pistil inferior, usually of three conjoined carpels.
Ovules, one or two in each carpel.
Fruit, a hard (woody) one-seeded **nut,** with cupule or developed involucre.

Coniferæ.—Trees or shrubs.
Leaves, mostly rigid, linear.
Flowers, diclinous, scaly, or very simple.
Staminate flowers in scaly catkins.
Pistillate flowers, in cones, or very simple.
Ovules in axils of scales, or solitary and naked.
Fruit, cones, woody, scaly, or fleshy.

Orchidaceæ.—Herbaceous plants.
Perianth, irregular, petaloid, six-parted, superior.
Stamens and style combined.
Anther-lobes, two, or four; pollen in masses.
Pistil inferior, one-celled.
Ovules many; attached in three series to the wall of ovary.
Fruit, capsular.

Iridaceæ.—Herbaceous plants.
Leaves, simple, narrow, long, parallel-veined.
Flowers, large.
Perianth, regular, petaloid, six-parted, superior.
Stamens, three, free.
Anthers, opening outwardly.
Pistil inferior, of three conjoined carpels.
Ovules, many, axile.
Fruit, capsular, opening by valves.

Amaryllidaceæ.—Herbaceous plants.
Leaves, simple, narrow, parallel-veined.
Perianth, regular, petaloid, six-parted, superior.
Stamens, six, free; anthers opening inwards.
Pistil inferior, of three conjoined carpels.
Ovules, many, axile.
Fruit, capsular, opening by valves.

Liliaceæ—
Leaves usually parallel-veined.
Perianth inferior, regular, petaloid, six-parted.
Stamens six, inferior.
Pistil superior, of three carpels conjoined.
Ovules, many, axile.
Fruit, capsular or berry-like.

Graminaceæ—
Stem fistular except at the nodes.
Leaves, simple, entire, alternate, with split sheaths, and ligules at junction of sheaths and blades; parallel-veined.
Flowers arranged in spikelets, with scaly bracts.
Perianth very reduced, not petaloid.
Stamens three (rarely one or six); anthers **versatile.**
Pistil superior, one-celled, stigmas two, hairy or feathery.
Ovule, one.
Fruit dry, with one farinaceous seed, adherent to its envelope.

Cyperaceæ—
Stems solid, triangular in section.

Leaves, simple, entire, with leaf-sheaths tubular (not split).
Flowers, sessile in spikelets, with scaly bracts.
Stamens, one to three; anthers basifixed.
Pistil one-celled, superior.
Style, one.
Stigmas, two or three.
Ovule, one.
Fruit, dry, one-seeded; wall not adhering to seed.

XII.—Explanations and Directions relating to the Principal Orders.

The following section contains, where it appears necessary, explanations of the plan of the flowers in some of the orders; and directions as to the parts to be specially examined in others, chiefly because it is in them that important variations are to be found within the order.

The student must not imagine that the directions or other particulars given, indicate exclusively what he should attend to or look for. Some characters he may seek in vain in some species or genera. Among so many various forms, a selection of characters only can be attempted. The great thing to aim at is the training of the eyes to see and of the mind to judge accurately.

Ranunculaceæ.

The principal British plants belonging to Ranunculaceæ are the Clematis, Anemone, Crowfoot, Buttercup, Marsh-Marigold, Hellebore, Columbine, Larkspur, Aconite or Monkshood, and Peony.

The abundant watery juice of the plants in this order is mostly acrid, and, in some of them, poisonous alkaloids are dissolved in the juice.

The leaves are opposite in Clematis; in most species of the order they are much lobed, and many species have the leaf-stalks expanded at the base.

In some genera the flowers are very simple and easily understood, the whole of the organs being arranged in spiral succession on the receptacle, which is convex or elongated. In others the flowers are symmetrical about one axis only, the antero-posterior.

The calyx in several genera is composed of brightly-coloured sepals, unequal in size, and unlike in shape. It is always external and inferior in position on the receptacle. The sepals do not overlap in the bud in Clematis, that is, they are valvate; they are imbricated in the other genera. In Larkspur the sepals are unequal, and the posterior sepal has a large spur. In Monkshood the posterior sepal has a large hood.

The corolla is absent in Clematis, in Meadow-Rue (Thalictrum), in Anemone, and in Marsh-Marigold (Caltha).

In several genera some or all of the petals are tubular, or funnel-shaped, or otherwise unusual in form; especially in Hellebore. In Columbine the petals all have spurs at the base. In Larkspur the two posterior petals are spurred, and the spurs extend downwards into the spur of the posterior sepal. In Monkshood there are two long curved posterior petals, which are covered by the hooded posterior sepal; and two or three other very slender rudiments of petals.

In those forms where the petals are of considerable size and nearly equal, they are imbricated in the bud (Ranunculus, Peony).

The stamens are usually very numerous, and have two-lobed anthers, opening by longitudinal slits at the lateral edges, on the face directed towards the sepals and petals (external).

The pistil is constituted of distinct superior carpels, each containing one or more inverted ovules. The styles are short and the stigmas simple.

In Ranunculus there is but one ovule in each carpel, attached at the base of the ventral suture (erect). In Clematis, Meadow-Rue, and Anemone, there is likewise but one ovule in each carpel, but its attachment is close to the top of the ventral suture (pendulous). The rest have more than one ovule to a carpel, and they are usually in two rows on the ventral suture.

The series having one ovule in a carpel produce dry fruits (achenes), which do not dehisce; in Ranunculus, commonly the carpels which ripen are much fewer than those produced.

The many-seeded carpels open along the ventral suture to allow the seeds to fall out (follicles).

The seeds contain a large endosperm, enclosing a small embryo possessing two cotyledons.

PRINCIPAL FORMS.

Clematis (Traveller's Joy), climbing shrubs with true wood; opposite stalked leaves, the leaf-stalks being organs of attachment.

Sepals four, petaloid, and valvate in the bud; no petals; many stamens; many carpels, each having one pendulous ovule; each flower producing achenes with long feathery styles.

Anemone—Flowers on peduncles without ordinary leaves (scapes), but having a three-parted involucre; sepals petaloid, imbricate in bud; no petals; stamens many; many carpels, producing achenes with pendulous seeds.

Ranunculus—Sepals three to five, imbricate in the bud, and soon falling (caducous); petals five; many stamens; many carpels, producing achenes with erect seeds.

The *Hellebore* group includes genera with regular and genera with irregular flowers, whose carpels become follicles.

Hellebore has five imbricated persistent sepals;

tubular petals; many stamens; in some species as few as three carpels, each with numerous ovules in two rows; the follicles become open at the top.

Marsh-Marigold (Caltha) has no petals.

Columbine has petaloid sepals, and petals with hollow spurs extending downwards between the sepals; many stamens; and five carpels becoming follicles.

Among the forms which are only symmetrical about one axis—

Larkspur has five petaloid sepals, the posterior having a spur into which the two larger petals send down a spur each; the other petals are small. The stamens are many; carpels, becoming follicles, one to five.

Aconite or **Monkshood** has the sepals petaloid and unequal, the posterior being large, and having a hood arching over the pair of peculiar curved posterior petals. The three other petals are very small; many stamens; three to five carpels, becoming follicles.

Actæa (Baneberry) is poisonous and has a many-seeded berry produced from one carpel.

CRUCIFERÆ.

The order Cruciferæ includes well-known garden flowers, such as Stock, Wallflower, and Candytuft, and the table vegetables, Cabbage, Kale, Broccoli, the Cresses and the Mustards, Radishes, etc.

The watery juices are pungent. The members of the order growing in Britain, are herbaceous. The flowers appear in terminal and axillary many-flowered racemes.

The sepals (4) and the petals (4) are free and inferior in position; and the petals are imbricated in the bud.

Stamens 6; an outer pair, opposite to the lateral sepals; and an anterior and a posterior pair, usually distinctly longer than the two lateral stamens (hence the stamens are termed tetradynamous).

The receptacle has four small glands opposite the sepals.

The pistil consists of two combined carpels, with two opposite longitudinal regions bearing ovules on the wall of the ovary. In most cases the two ridges along which the ovules are attached meet and form a secondary partition. The style is short, and the stigma has two lobes.

The ovules are either half-inverted or curved, and their mouth is directed upwards.

The fruit is almost always dry, and forms two valves which open from below upwards, leaving the seeds attached to the partition. In a few genera the fruit breaks across into one-seeded portions.

The seeds, when ripe, contain nothing but the embryo, and the two cotyledons become foliage-leaves.

In many genera the fruit is elongated, and the valves separate entirely when ripe. In a second group the fruit is short and broad. In a third series the fruit is short, the septum or partition is narrow, while the valves are compressed, and so become doubled and somewhat boat-shaped. Finally, the fruit may even be found not to open at all, the seed being solitary; or to break up into two or more joints, by a transverse division.

Divisions.—The first division of the order (that characterised by the siliqua) includes the Stock, Wall-flower, Water-cress, Cuckoo-flower, Hedge-mustard, Cabbage, Turnip, Mustard, and Charlock.

The second division (having silicles with a broad septum) includes Whitlow-grass and Scurvy-grass.

The third division (silicles with a narrow septum and broad concave valves) includes Shepherd's Purse, which has many-seeded fruits, the Wart-cress and ordinary Cress, which often have two, four, or six stamens, the fruit of the Wart-cress having only two seeds and not opening.

The fourth division includes some curious forms of fruit. In Woad the fruit does not open, being one-celled

and one-seeded. In Seakale the fruit separates into two joints, the lower without a seed, the upper one-seeded. In the Sea-rocket, each joint has one seed. In the Radish the fruit is long and breaks up into one-seeded portions.

CARYOPHYLLACEÆ.

The Caryophyllaceæ (Pinks, Campions, Stitchworts, and Chickweeds) show comparatively slight differences.

The calyx is gamosepalous, with four or five lobes in the Pinks and Campions; it often closes over the fruit, being persistent. The sepals are free in the Stitchworts and Chickweeds, and imbricated in the bud.

The petals in some species are very minute, or absent altogether. There are mostly four or five petals, with a distinct linear claw, and a lamina, often incised, at right angles to it. They are imbricated or contorted in the bud, and attached to the receptacle below the pistil. One genus (Lychnis) is remarkable for its scale-like appendages to the petals.

The stamens are usually twice as many as the petals, but in some species they are as few as three or five. When there are ten, those belonging to the inner whorl opposite to the petals may be adherent to the claws of the petals. The rest are inserted at the same level.

Both petals and stamens are often raised above the level of the calyx in the Pink and Campion group, by a prolongation of the receptacle.

The pistil is inferior, and the ovary globular or ovoid, containing one cell with a central basal mass of ovules, attached free from the apex; and they are half inverted. The styles are found varying from two to five, with stigmatic surfaces on their inner aspect.

The fruit is dry—a capsule opening by teeth at the apex, or completely separating into three to ten valves.

The seeds are few in some cases; often many, kidney-shaped, and beautifully marked on the outside. They

contain an embryo, with two cotyledons surrounded by farinaceous endosperm.

The species of Dianthus have but two styles, and the capsule opens by four teeth at the top.

Silene (Catchfly) has the calyx inflated; and the blades of the petals have two scales at the base. The ovary usually has three incomplete cells in the lower part, and the styles are generally three. The capsule is six-toothed at the top.

The Campions (Lychnis) have five styles; in the Ragged Robin the petals are cleft into four lobes. In the Red Campion the petals are bipartite. This species is often dicœcious, having staminate flowers on one plant, and pistillate on another. The petals in all the Campions have the characteristic lobe at the base of the lamina.

In the Mouse-ear Chickweed (Cerastium), the petals are notched and the capsules cylindric. In Stellaria (Stitchwort and Chickweed) the petals are bifid, the styles are three, and the capsule is six-valved and globular.

LEGUMINOSÆ: SECTION PAPILIONACEÆ.

This portion of the order Leguminosæ includes Furze and Broom and Sweet-Pea; the fodder-plants, Clover, Lucern, Sainfoin; many whose seeds are eaten, Beans, Peas, Broad Beans, Lentils.

The leaves in most species are compound, and have stipules.

Many have a two-lipped calyx, and each lip is further divided; usually there are two teeth in the upper lip, and three in the lower, five in all. The odd lobe is lowest.

The corolla has five unequal petals. The upper (posterior) petal is largest; in the bud it is folded double, outside the others, which are arranged in two pairs. The posterior petal is the *standard;* next within this is the pair of lateral petals, called *wings;* and within

these the *keel*, consisting of the anterior pair of petals placed close together, so as to appear like one, and interlocked by the front edge. Usually they can be easily separated, and each is fixed to the axis by a distinct short claw.

Within the keel the stamens are included; the ten stamens rise by short filaments from a tube which is attached to the margin of the small concave receptacle (in Broom and Furze); in very many genera, such as the Clovers, Vetches, and Beans, the upper filament is easily separable from the tube of the other nine; the anthers are often versatile.

The pistil consists of one carpel, arising from the receptacle, and enclosed within the staminal sheath; the style is often bent, and the stigma is terminal and simple.

The ovules are two or more, attached alternately along the two edges of the ventral suture.

The fruit is a dry pod, straight or curved, usually opening along both sutures. In some cases the pod does not open along the sutures, but each of the seeds remains in its own portion of the pericarp, which breaks off so that there are as many joints as seeds (Horse-shoe Vetch). Others are many-seeded, but do not open at all. Some only ripen one seed, and do not open.

The seeds contain, within a hard skin, a pair of fleshy cotyledons lying face to face, each being convex outwards.

The Furze and Broom group (shrubs) have the filaments all united. Furze has short branches ending in spines, arising in the axil of small leaves which are triangular and acuminate; the calyx is deeply two-lipped.

The common broom is not spiny.

Clovers, Vetches, Peas, and Beans, have the upper filament more or less completely free from the staminal tube.

Medick has, in many species, a remarkably coiled fruit, not opening, and beset with tubercles.

Clover has leaves with three leaflets, and stipules adherent to the leaf-stalk. The flowers are in heads. The petals persist around the fruit; the claws of the keel and wings adhere to the tube of the filaments. The fruit is small, frequently does not open, and has at most four seeds, often but one.

In Sainfoin the fruit does not open, and is but one-seeded.

Vetches and Peas have prominent ridges on the stems, and leaves with pairs of leaflets, the midrib ending in a tendril. In the flower the wings adhere to the keel.

ROSACEÆ.

The leaves in Rosaceæ have stipules.

The petals are attached to the margin of the receptacle; they have no claws, and are imbricated in the bud. Lady's Mantle and Burnet have flowers simpler in structure, without petals.

Stamens usually in many series at the edge of the receptacle, and incurved in the bud. In Plum and Cherry, there are 15 to 20 stamens; in Lady's Mantle 1 to 4; in Agrimony 5 to 10; in the Great Burnet 4; in Sanguisorbs the heads have some flowers pistillate only; others staminate or perfect.

The pistil consists of one or more distinct carpels, which, in some, are enclosed or embedded in the receptacle.

The fruit consists of drupes, achenes, pomes, and various combinations of carpels with the enlarged receptacles.

The seeds are without endosperm.

The Rosaceous flowers chiefly accessible to us differ principally in the characters of the receptacle and the mode of insertion of the carpels, in their number, and in the consistency of the fruit.

Thus, in the Plums and Cherries there is a deciduous calyx on a small concave receptacle, in which only one carpel arises. The carpel contains two ovules; one of these ordinarily becomes a seed.

The ripe fruit consists of nothing but the carpel. Its inner wall becomes a hard woody shell enclosing the seed; the pulp is separate from the shell when fully ripe, but not before; and there is an outer skin. This fruit is a drupe.

In Meadow-Sweet the carpels are five or more, distinct, with two ovules in each.

Each carpel becomes a short compressed follicle (dry fruit); all the follicles from one flower are twisted together, and lie in a horizontal plane. The calyx here is persistent with the fruit.

Next, we notice the Bramble, Raspberry, and their varieties. They have a receptacle, which is extended at the side, to bear the calyx, and corolla, and stamens; and lengthened in the centre to bear the very numerous carpels on the outer surface. There are two ovules in each carpel.

Every carpel that develops becomes a little one-seeded drupe, with a thin shell. Thus each flower produces a central prolonged receptacle, covered by little drupes, usually fewer than the carpels of the flower.

The Strawberry has its calyx attached to a receptacle which is laterally extended, and which persists in the fruit. The carpels are very many, and each contains one ovule. The central part of the receptacle, that which bears the small carpels, is convex, and often becomes very large and succulent in the fruit. This is a receptacular fruit, studded with minute achenes (not opening).

The Cinquefoil and Silverweed, differ from the Straw-

berry, in bearing achenes on a receptacle which does not become succulent.

Agrimony has a concave receptacle, with narrowed mouth. The receptacle includes two carpels (only the styles protruding from the mouth) with one ovule in each. The fruit has one or two achenes, inside the enlarged hard receptacle, which has hooked spines outside.

The Wild Rose has a deeply-concave receptacle, containing many carpels, each with one ovule, attached to its wall; the simple styles, one to each carpel, protrude from the narrow mouth of the receptacle.

In the fruit the receptacle becomes thickened and fleshy, enclosing numerous achenes covered with hairs.

Pears and Apples have a limited number of carpels, not more than five, each with two ovules. The walls of the carpels and the tube of the receptacle are closely united. Each carpel has a cartilaginous lining or inner wall. The carpels are deeply enclosed in the fleshy mass of the receptacle. The fruit is a pome.

In the Medlar the fruit has the same essential structure; but there is a much larger concave area at the apex of the fruit than in the Apple; the carpels are regularly five, with bony walls, and with one seed in each.

The Hawthorn has fewer carpels, often aggregated (in the fruit) into one bony mass, surrounded by the fleshy product of the receptacle.

UMBELLIFERÆ.

This order includes Hemlock, Celery, Parsley, Fennel, Carrot, Parsnip, Chervil, and Water Dropwort.

The fruit is most characteristic; the receptacle is deeply concave, and the carpels are sunk in it, and covered by a superior disk, in the middle of which the styles emerge.

The carpels must be looked on as inverted, for the

axis is prolonged between them; and they often separate, so that each hangs from the top of one of the forks of this axis.

Each carpel has five primary ridges, and in some four secondary ridges. Between the ridges are grooves, and in the tissues below the grooves are lines of oil-bearing tissue. The seeds have a small embryo, and large endosperm.

In describing umbelliferous plants, notice—

(1.) The extent of division of the leaves.

(2.) Whether there is an involucre of bracts at the base of the primary rays of the inflorescence, and another at the base of the rays of each small umbel; whether the umbels are simple, or, as in some, the flowers sessile.

(3.) Whether the outer flowers of an inflorescence differ from the inner in size of petals, or characters of stamens or pistil.

(4.) The minute inflexed middle point often found in the petals.

(5.) The incurved filament of the stamens.

(6.) The shape of the superior disk.

(7.) The ridges on the surface of the fruit, and the oil-glands in the furrows between.

(8.) The hard (often horn-like) endosperm of the seed.

COMPOSITÆ.

The herbaceous plants that are included in the British Compositæ have leaves without stipules.

The inflorescence consists of many small flowers crowded and sessile on the enlarged end of the peduncle or common receptacle; the outer flowers become matured first (centripetal opening). There is an involucre of specialised bracts, often in many series.

In some forms the dilated top of the peduncle is club-shaped, in others flattened.

The small flowers are commonly of two kinds, pistillate only, and complete. In some species, some of the flowers in a head are neuter, having neither stamens nor fertile pistils. In other species there are found plants whose heads are principally composed of staminate flowers; while other plants of the same species produce heads with pistillate flowers.

The calyx is but little developed in this order; when present in any form it is superior. It is most manifest in the development of the pappus in the fruit.

The corolla is superior and gamopetalous. It has two principal forms, which, in the Daisy, occur in the same head. The one is tubular (in some bell-shaped), with five lobes; the other is strap-shaped, sometimes elliptic, like a tubular corolla opened up along one line, so that the tube is very short, and the rest of the corolla looks ribbon-like, with some small teeth at the apex for corolla-lobes. When both kinds of corolla are present in one head, the strap-shaped are always on the outer part of the head, forming ray-flowers, as in the Daisy.

When the flowers are of two kinds in a head, the inner flowers have tubular corollas.

The stamens are inserted in the tube of the corolla; the five filaments are inserted separately; but the anthers are long, and their connectives adhere together on either side, forming a tube of anthers, with filaments attached at the base; the pollen-sacs open inwardly, and in many forms there are special processes of the connectives, both at apex and base.

The pistil is inferior; it contains only one cavity, containing one ovule, attached to the base of the cavity. The style is single, but more or less deeply divided at the apex into two lobes, which are usually narrow, and have stigmatic edges.

The fruit is dry, and does not open to discharge the seed, which has no endosperm; it is thus an inferior achene; but it bears at its apex or on its surface a

number of hairs, sometimes attached to a beak; the number and character of these hairs (called the pappus) is important in distinguishing the species. These light hairs are the great means of distributing the seeds. The Daisy, Chamomile, and Milfoil have no pappus.

In the Compositæ, notice especially—

(1.) Whether the heads are combined in groups on any plan, or are solitary and ungrouped.

(2.) The consistency, the number of series, the margin, and the gradual changes from without inwards, in the bracts of the involucre.

(3.) The shape and consistency of the enlarged peduncle bearing the flowers.

(4.) Whether the flowers are all perfect, or pistillate only, or staminate only; whether all or some have tubular corollas; or whether all or some have ligulate (strap-shaped) corollas.

(5.) The presence or absence of upward and downward prolongations from the anthers; whether the anthers protrude much beyond the corolla.

(6.) The shape of the style and stigmatic lobes.

(7.) The shape and external markings of the fruits, and the kind of pappus; how many series of pappus hairs there may be.

Very many Composites have all or many flowers tubular. Of these, Burdock has the outer bracts hooked; the Thistles in general have spinous-toothed leaves, and some of the bracts spiny.

The Daisy is notable among the common forms for having no pappus; while the Thistles, Dandelions, and Groundsel have the pappus prominently developed.

The group which includes Dandelion, Lettuce, and Chicory, has the corollas all strap-shaped, and the juice milky.

SCROPHULARIACEÆ.

The calyx is gamosepalous, inferior, four or five parted.

The corolla is gamopetalous, four or five lobed. In one series the upper lobes are external in the bud; in another, enfolded by the lower.

Stamens in most are four, two being longer; in Verbascum there are five; in Speedwell, two. They are always inserted on the corolla tube.

Pistil superior, of two conjoined carpels, each having many ovules attached to the wall between the two cavities.

The fruit is capsular; seeds, in many, large and beautifully marked; embryo curved, and enclosed in endosperm.

Mullein has a rotate corolla and five stamens.

Toad-flax and Snapdragon have a gamopetalous corolla, the tube of which is closed near the top (personate or masked). The upper lip of the corolla is erect, and closes over the others in the bud; the lower lip spreads, and has a middle, smaller lobe, and two lateral lobes. The corolla is either spurred (Toad-flax) or bulging (saccate) at the base (Snapdragon). There are four fertile stamens, and sometimes a fifth filament, without an anther. The capsules open by small pores or valves.

The Foxglove has a large corolla, slightly lobed at the apex; the four stamens, in two pairs, on stout filaments, two longer and two shorter, have two-lobed anthers, set at an acute angle at the top of the filament.

In Veronica (Speedwell) the corolla is almost regular, and the tube is very short; there are four lobes, not quite equal. The two stamens are attached to the tube of the corolla, one at either side of the upper lobe.

LABIATÆ.

This order includes the Mints, Peppermints, Penny-royal, Marjoram, Thyme, Basil, Sage, Ground Ivy, Self-heal, Skull-cap, Horehound, Woundwort, Deadnettle, Germander, and Bugle. Very many of these have in their leaves great numbers of minute bags of fragrant oil.

The leaves have no stipules. The inflorescence, in the axil of the leafy bracts, is definite; the pedicels are usually very short or absent; in some genera, the apparent whorls of flowers are closely grouped as spikes or heads.

The calyx is gamosepalous, five-toothed, and many-ribbed; it persists, enclosing the fruit.

The corolla is attached to the receptacle outside and below the pistil; it falls after the fertilisation of the ovules, and it has usually two distinct lips. The upper lip overlaps and envelops the lobes of the lower lip in the bud.

The stamens are on the corolla-tube; almost always there are four, two longer and two shorter.

The pistil has two superior carpels, having one combined style issuing from between them; the style is bifid usually.

The ovary of each carpel becomes deeply indented in the middle as the ovules develop, one in each lobe; thus the style becomes basal and median.

Fruit of four (sometimes fewer) nutlets, each containing one seed, without endosperm.

In the description of plants of this order, note carefully—

(1.) The structure of the group of flowers in the axil of each bract; which flower in the group is largest or oldest; and then, how the appearance of a whorl of flowers is produced; and in species, where there is a crowding together of the apparent whorls, the form and structure of the compound inflorescence.

(2.) The number of the ribs visible on the outer surface of the calyx, and whether its teeth are equal and symmetrically placed; or whether the teeth are in two groups, making a two-lipped calyx.

(3.) The form of the corolla, whether nearly regular, or distinctly two-lipped; the shape of the upper lip (if present); shape of the lower lip and its lobes; relative length of corolla-tube to calyx.

(4.) The number of filaments; the number of imperfect stamens; the number of perfect stamens. When there are four, of different lengths, note which pair rises to the greater height. Notice particularly the position of the anther-lobes on the filament before they open, and their position after the pollen is shed.

(5.) Whether the stamens approach one another, or diverge, or are they parallel? are they protruded or hidden?

(6.) Note the shape and character of surface of the nutlets, and their number.

(7.) Note the glands on the receptacle.

Sage (Salvia) has but two stamens, with the connective jointed to the filament, and extended, bearing at its upper end one perfect anther-lobe, at the other end a rudimentary lobe.

PRIMULACEÆ.

In this order notice particularly the extent to which the calyx may be divided; the relative length and position of the stamens in the corolla-tube, and the height of the style; also the mode of bursting of the capsule.

The capsule opens by valves in the Primrose group; by a transverse lid coming off, in the Pimpernel series.

ORCHIDACEÆ.

In the Orchidaceæ, notice accurately the distinctions between the outer and the inner series of perianth-members.

Describe completely the shape of the lower (inner) member, the *lip*, and all its processes, spurs, or hairs.

The main distinction to observe about the stamens is the number of fertile anthers. In Venus's slipper (Cypripedium), there are two distinct anthers placed on either side of the column. In other Orchids look for a single two-lobed anther directly opposite to the lip.

Next in importance, notice the number of pollen-masses, for the pollen-grains are rarely separate, or easily separable, the grains being united by an elastic web.

When the pollen is in separate masses, notice their shape, usually pear-like, tapering to the base; the stalk of the pollen-mass ends in a gland, which in some forms is protected in a pouch.

The filaments of the stamens are joined to the style, forming the *column*. The anther lobes are above the *beak* which ends the style, and above the stigmatic surface.

The pistil is of three combined carpels, and is inferior. The ovary is one-celled, having many ovules attached to the wall in three series.

The fruit is capsular, and opens by three valves bearing the seeds, separating from three ribs representing the dorsal sutures. Thus the fruit is like a three-cornered box whose sides fall out while the angles remain.

The seeds are very numerous, minute, and without endosperm.

The genus Orchis has its pollen-glands in one pouch, while the genus Ophrys (Bee, Spider, and Fly orchis) has its pollen-glands in two pouches.

Some other forms of Orchidaceæ with one stamen, have the anther hinged on the top of the column.

IRIDACEÆ.

In Iridaceæ notice the kind of underground stems; d the mode of folding of the leaves and the bracts.

In Crocus there is a long superior perianth-tube, and the ovary is underground, and the slender style passes up through the long cylindrical perianth-tube; there are three stigmas.

Iris (Flag) has a large perianth, with the outer segments larger than the inner. The three stamens are opposite to the outer lobes of the perianth, the long narrow anthers open outwards, and each is overarched by one broad petaloid stigma.

Gladiolus has the perianth almost bilabiate.

Describe the large capsule carefully; the pistil divides into three portions at the dorsal suture, so that each valve is made up of parts of two carpels with one-half the seeds belonging to one carpel, and one-half to the adjacent carpel. The seeds have the embryo surrounded by endosperm.

LILIACEÆ.

Among Liliaceæ notice and describe carefully the structure of the bulbs or corms, when met with, the kind of inflorescence, and the bracts; the distinctness or union of the members of the perianth, and the mode of dehiscence of the fruit.

Herb Paris, Asparagus, Ruscus (Butcher's Broom), Lily of the Valley, and Solomon's Seal, have the fruit in the form of berries.

Squill, Hyacinth, Leeks and Onions, Fritillary, Tulips and Lilies, bear capsules which open by splitting at the dorsal suture, and that is, through the middle of each carpel.

Colchicum (Meadow Saffron) has a capsule in which the three partitions split, so that three valves corresponding to the three carpels are formed.

GRAMINACEÆ.

The varieties of arrangement of the flowers of Grasses are very great. It is necessary in some cases to examine

the inflorescence carefully in order to discover which is the spikelet and which is an individual flower.

An individual flower in a Grass is contained most commonly within two bracts called *pales;* the lower of these is the larger, and is often concave and boat-shaped, the upper being flat, placed like a deck closing the cavity of the lower. The two edges of the upper bract are commonly bent inwards.

Within this are, upon the floral receptacle, some minute scales at the base (representing a perianth), then three stamens with long filaments attached to the middle of the linear anthers, making them versatile; the filaments mostly protrude the anthers from the flower, and they thus are suspended. (Vernal grass has but two stamens.)

The pistil is superior, and has but one cell and one ovule. The styles are two, often with hairy or feathery stigmatic processes.

The fruit has the carpellary wall thin and adhering, and often the upper, sometimes also the lower bract adheres closely to it.

The seed has a floury endosperm and small embryo, on one side of the base of the endosperm.

A spikelet may have one or a pair of empty bracts at its base, that is, bracts which contain neither stamens nor pistil. It may have one or more staminate flowers; and one or more pistillate flowers; and smaller empty bracts at its apex.

The common Cat's Tail and Fox-Tail Grasses have spikelets contalning only one flower above a pair of empty bracts; the Fox-Tail Grass has no second pale within the pale enclosing the flower.

The spikelets are combined together in very various ways. Sometimes the bracts are much compressed, and attached to one principal axis by very short stalks, and then combined into a closely-packed mass of spikelets

like a cylinder. When the stalks of the spikelets are longer, a panicle is often formed, as in Oats.

In Wheat and Barley the spikelets are sessile in little pits in the side of the main flowering axis; and the spikelets are placed sideways (or broadside) on the axis. Wheat has spikelets with at least three flowers each. Barley has three spikelets (each one-flowered) seated in one pit on each side of the main axis. When the side flowers are staminate only, the fruit is produced in two rows only; when all the flowers are perfect, it is in six rows.

In this order, specially seek (1) to understand the spikelet and its structure.

(2.) To separate and examine a single perfect flower.

(3.) To comprehend the building up of the inflorescence, of spikelets.

Never hastily assume that the spikelets are built up into a compound spike. Often that which appears to be a close mass of sessile spikelets is a panicle with short stalks on the main axis bearing several stalked spikelets.

Describe the general shape of the spikelet as a whole, and whether it is laterally or dorsally compressed.

In describing the elements of the spikelet, state—

(1.) The number of empty bracts at the base, and their shape.

(2.) Whether, if there are two, they are equal or unequal.

(3.) Whether the margins are entire or toothed.

(4.) What their size is, in relation to the other bracts of the spikelet.

(5.) Whether there is any projection from their base or their apex like a bristle or needle; if present, call it an *awn*, and state its relative length.

(6.) Mention the number (if conspicuous) of principal veins in the bract.

Describe further the bract or bracts belonging to

staminate or perfect flowers, and describe each separately, for they are rarely alike; notice particularly whether there is an awn in the outer bract; and the veins of the inner bract.

Notice the size of the fruits relatively to the floral or the empty bracts, and whether one or both floral bracts adhere to the fruit.

CYPERACEÆ.

In Cyperaceæ attention should be paid to the principal items mentioned under grasses, and especially to the question whether the flowers are staminate, or pistillate, or perfect: and also to the tubular envelope surrounding the pistil in the great genus Carex.

GLOSSARIAL INDEX.

The numbers refer to the pages.

In most instances the technical terms are defined or explained at the pages named. A few explanations are given here of terms not directly defined in the book, where it seemed useful.

ABORTIVE parts of flowers, 27, 38.
Achene, 54, 73, 80.
Acicular (needle-shaped), 18.
Acuminate, applied to leaf-apex, 20.
Adventitious roots, those not developed on the primary root-axis, 5.
Aërial roots, those developed entirely in air, and not entering earth or water, 6.
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Amentaceæ (catkin-bearers), 70.
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Angiospermous, 63.
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Annual branches, 8.
Annual stems, 8.
Anterior part of a flower, 30, 60.
Anther, pollen-bearing part of stamen, 37-43.
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Apex of leaf, 20.
Apical style, 47.
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Arrangement of leaves, 17.
Ascending ovules, 50.
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Attachment of ovules, 49-51.
Awn, 91, 92.
Axil, 6.
Axile attachment of ovules, 51.
Axillary branches, 6.
Axillary flower, 24.

Axis (root), 3,
Axis (stem), 6.
Axis (flowering), 9, 24.

BARK, the dead tissue in the outer part of a woody stem that possesses closed vascular bundles, and increases by annual rings. Bark always contains cork-cells which cut off the dead from the living tissues, 12.
Basal style, 47.
Basifixed anther, 39.
Berry, a succulent fruit, 56.
Betulaceæ, 68.
Biennial plant, living during portions of two seasons, 10, 63.
Bilabiate (two-lipped) calyx, 32; corolla, 36.
Blade of leaf, 13, 18-20.
Boraginaceæ, 67.
Bract, a leaf-like member (phyllome) in the axil of which a flower grows, 25, 27, 45, 84; bracts in whorls form an involucre, 25.
Bracteole, a small bract on the pedicel of a flower, 25.
Branches, 6, 8, 10.
Buds (leaf), 6, 9, 10, 22.
Buds (flower), 26, 32, 34.
Bulb, 9.
Bundles, vascular, special groups of cells, fibres, and vessels found in all flowering plants, 11, 12.

CADUCOUS, falling early, before other parts of the flower, applied to floral envelopes, 31, 34.
Calyx, 27-32.
Cambium, tissue remaining permanently capable of multiplying; the means by which trees increase in thickness, 12.
Capillary, as slender as a hair, 39.
Capitulum (a form of inflorescence), 25.
Capsule, a kind of fruit, 56, 57, 76, 77.
Carpel, 43, 44, 46, 47, 53-59.
Caryophyllaceæ, 65, 76.
Catkin, 25, 68.
Cauline, 14, 16.
Caulome, any part of a plant belonging to the class of stems or axes bearing lateral members, 63.
Cells, a term for the minute elements of which plants are made up, and by the growth and division of which they increase in size; often used also to denote larger cavities in ovaries and fruits.
Cellulose, the substance which forms the first boundary of vegetable cells, 5.

Cell-wall, the firm boundary between the cells of plant-tissues.
Centripetal (seeking the centre), applied to the successive development of members or flowers from the outer to the inner, 82.
Claw of petal, 33, 76, 78.
Closed vascular bundles, those whose cambium is soon exhausted, and surrounded by permanent non-dividing cells, 12.
Coherent anthers, 42.
Cohesion, 29.
Column (in orchids), 88.
Complete flower, 26.
Compositæ, the order in which the flowers are collected in dense compound groups, often looking like one large flower, 66, 82.
Compound leaf, 14.
Compound pistil, 46, 49-51.
Condensed axis, 7.
Conduplicate folding of leaves, 23.
Cone (form of inflorescence), 25; (form of fruit), 56.
Coniferæ (cone-bearing order), 69.
Connate anthers, 42.
Connective of anthers, tissue connecting the anther-lobes, sometimes prolonged beyond them, 39.
Contorted petals, 32.
Convolute folding of leaves, 24.
Cordate leaf, 19.
Corm, applied to an underground condensed stem constituting a reserve-organ, and having few scales, 9, 10.
Corolla, 27-30, 33-36.
Cortex, a term for the part of a stem outside the vascular bundles, also including the part outside the cambium, in trees with open vascular bundles, 11, 12.
Corymb, a form of inflorescence, 25.
Cotyledon, 16, 59, 63.
Crenate, term applied to leaf-margin, 21.
Crescentic pollen-sacs in anthers, 40.
Cross-sections. *See* Transverse sections.
Cruciferæ, cross-bearing order, referring to the arrangement of the petals, 64, 74.
Crumpled folding of leaves, 24; of corolla, 34.
Cuneate, 19.
Cupule, the woody cup or envelope forming part of the fruit in the order Cupuliferæ, 69.
Cupuliferæ, the oak and hazel order, 69.
Curved ovule, 52.
Cyme, a general term including all forms of definite inflorescence.
Cyperaceæ, the sedge order, 70, 92.

DECIDUOUS, applied to sepals and petals, 32, 34.
Decurrent leaf-blades, 20.
Decussate leaves, 18.
Definite inflorescence, 24.
Dentate, applied to margin of leaves, 21.
Diadelphous, in two sets ; applied to stamens, 38.
Diagram, floral, 59.
Diclinous, 27, 45.
Dicœcious, 27.
Discharge of seeds, 57.
Disk, 28, 81.
Divergent, applied to sepals, 31 ; to petals, 34.
Dorsal suture, applied to carpels, 44.
Dorsifixed anthers, 39.
Drupe, form of fruit, 56, 57, 80.
Dry fruits, 53-56.

EMARGINATE, applied to leaf-apex, 20.
Embryo-plant, the condition in which the future plant exists in a seed, 52, 58, 59, 63.
Endocarp, term given to a special inner layer of pericarp in a fruit, 56.
Endosperm, food stored in a seed for the embryo-plant, 58.
Ensiform leaf, 19.
Epidermis, the outer protecting layer of a young plant, 11, 44.
Erect ovules, 50.
Exserted anthers, protruding beyond other parts of a flower, 41.
Extra-axillary position of branches, 6.
Eyes, buds on underground stems, 5, 9.

FACE of anther, that surface usually directed towards centre of flower, 40.
Fasciculate, in a bundle starting from one point, applied to roots, 5.
Fasciculate leaves, 18.
Fertilisation, the process by which the germ-cell of a plant is acted on by the sperm-cell, which in flowering plants is called a pollen-grain, 43, 44, 47, 48.
Fibrous root, 5.
Filament of stamen, 37-39.
Filiform, thread-like, 39.
Fistular (hollow), applied to stem, 11.
Floral axis, that portion of the stem on which flowers (one or more) are borne.
Floral diagram, 59-62.
Floral envelopes, 27-36.

Floral organisation, 26.
Floral receptacle, the portion of the axis from which every part of a flower originates, 28.
Flower, an organised grouping of members in a plant, including one or more members taking part in reproduction (stamens or pistil), or leaves modified in relation to reproduction.
Flowering plants, those which possess flowers, in which germ-cells are formed in ovules, and sperm-cells (called pollen-grains) in anthers, resulting in the formation of seeds in which an embryo-plant grows.
Folding of leaves in buds, 21, 22.
Follicle, a fruit produced from one carpel, 54, 73, 80, 81.
Free central attachment of ovules, 50.
Fruits, 52-58.

GAMOPETALOUS COROLLA, 29, 34-36.
Gamophyllous perianth, 30.
Gamosepalous calyx, 29, 32.
Germ-cell, developed in the nucleus of an ovule, destined to be fertilised by the contents of the pollen-tube, in order to form an embryo-plant, 52.
Germination, growth of a young plant out of a seed until it can gain its food entirely from earth, air, and water.
Glabrous, a smooth surface having no hairs, 15.
Glands, 28.
Glume, name often given to some of the bracts in the inflorescence of grasses; not used in this book because of the confusion attending its use.
Graminaceæ (grasses), 70, 89.
Gymnospermous, 63.
Gynœcium, 63.

HAIRS, of root, 4.
Hairs on stem, 7.
Hairs on leaves, 14, 15.
Herbaceous perennial, 8.
Hermaphrodite flowers, those possessing both germ-cells and pollen-grains in ovules and pollen-sacs.
Horizontal ovules, 50.
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Imbricated petals, 34.
Imbricated sepals, 31.
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Incomplete flower, 26.

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Inferior ovary, 28, 46.
Inflorescence, or flower-grouping, 24-28.
Integument of ovule, 52.
Internode, space on stem between successive leaves, 6, 7, 10.
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Iridaceæ, 69, 89.

LABIATÆ, 67, 86.
Lamina (blade), 13.
Lanceolate leaves, 19.
Lateral members (phyllomes), 6, 13, 16.
Lateral style, 47.
Leaflet, distinct segment of a compound leaf, 14-16.
Leaf-system, 13-24.
Legume, or pod, a form of fruit, 55, 65, 78.
Leguminosæ, the pod-bearing order, 65, 77.
Ligulate corolla (strap-like), 36, 83.
Ligule, a small blade at the junction of lamina and sheath in grasses, 71.
Liliaceæ, 70, 89.
Limb (blade of petal), 33, 35.
Linear, 19.
Lobed leaf, 21; calyx, 29, 32; corolla, 29, 35.
Lobes of anthers, 40.
Lobes of compound pistil, 46.
Loculus, separate cavity or chamber of ovary, 48.
Lomentum, 65.
Longitudinal sections of stems, 12.

MARGIN of leaves, 20.
Marginal stamens, inserted at the margin of a hollowed-out or laterally-extended receptacle, 37.
Masked corolla, 36.
Members, lateral, 6, 16, 25, 29.
Membranous leaves, 26; sepals, 31; petals, 33.
Midrib of leaf, 14, 22; of carpel, 44.
Monadelphous stamens, 38.
Monocarpic plants, 63.
Monœcious, 27.
Mouth of ovule, 52.
Mucronate (applied to apex of leaf), 20.

NECTARIES, petals transformed into, 34.
Neuter flowers, producing neither pollen nor ovules, 27.
Node, region where a phyllome is attached to a stem, 4, 7, 11.
Nucleus of ovule, 51.
Nut, a kind of fruit, 55, 69.

OB, a prefix used to signify the converse of what is signified by the rest of the word.
Obcordate, the converse of cordate; that is, having the broader region at a distance from the attachment, 20.
Oblique, unsymmetrical, or unsymmetrically attached, applied to leaves or floral members.
Oblong leaves, 19.
Obovate, the converse of ovate, 19.
Open vascular bundles, those possessing permanent cambium, and capable of continued growth, 11.
Opposite leaves, 17.
Orbicular, applied to leaves, nearly circular, 19.
Orchidaceæ, 69, 87.
Order of parts of a plant, 3.
Orders, principal, 64-92.
Organically adherent, cells so united as not to be separable without tearing, 6.
Organisation of flowers, 26.
Oval leaves, 19.
Ovate leaves, 19.
Ovary, the part of a carpel or pistil in which ovules are developed, 43, 47, 48-52.
Ovule, 43, 44, 49-52.
Ovules on wall of ovary, 51.

PALES, the bracts enclosing a flower in grasses, 90.
Palmate leaf, 15.
Panicle, form of inflorescence, 25.
Papilionaceous corolla, the form found in most British Leguminosæ, 65, 77.
Pappus, the hairs developed on the fruit in Compositæ, 84.
Parasitic roots, those obtaining nourishment (directly) from the tissues of other plants, 6.
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Petaloid, applied to parts not petals, but coloured like petals, 31.
Petals, 29, 33.
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Phyllode, 16.
Phyllome, 13, 19, 62.
Pinnate leaf, 15.
Pistil, the part of a flower in which ovules are developed, 28, 43-53.
Pistillate flowers, 27, 45.
Pith, the central tissue of a stem having the concentric arrangement of parts, 11.
Plan of flower, 60.
Plicate folding of leaves, 24.
Plumule, the first leaf-bud in the embryo-plant, 63.
Pod, a form of fruit, 55, 78.
Pollen-grains, the sperm-cells in flowering plants, developed in anthers, 37, 43.
Pollen-tube, that growth from a pollen-grain which actually fertilises an ovule, 52.
Pollinia, masses of pollen-grains cohering, 43, 88.
Polyadelphous stamens, 39.
Pome, a form of receptacular fruit, 56, 81.
Pores in anthers, 42.
Porous opening of capsules, 58.
Posterior, 30, 60.
Prefloration, condition of parts of flower in the flower-bud, 64.
Prefoliation, condition of leaves in the leaf-bud, 64.
Primulaceæ, 68, 87.
Prostrate stem, 7.
Protoplasm, the living substance of plants, containing many complex substances, out of which the plant makes all its solid products, and by means of which it acts and feeds, 5.
Pseudo-bulb, 64.

Raceme, form of inflorescence, 25.
Radical leaves, 14, 16.

Radicle, the primary root developed on the embryo-plant, 5, 59, 63.
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Receptacular fruits, 54, 56, 57, 80, 81.
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Reflexed sepals, 31.
Regular corolla, 33.
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Reserve food, food stored up by a plant for use after a season of rest, 8.
Revolute folding of leaves, 24.
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Ringent, widely-open form of gamopetalous corolla, 36.
Ridges within ovary, 50, 51.
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Scar on seed, 58.
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Seam of seed, 58.
Secondary roots (all except the primary root), 5.
Seed, peculiar to flowering plants, containing an embryo-plant, adapted to remain undeveloped for some time after its formation, 52-59.
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Sepaloid, 33.
Septum, 44.
Serrate, applied to leaf-margin, 21.
Sessile flowers, 25.
Sessile leaf, 14.

Sessile ovules, 52.
Sessile stigma, 48.
Shape of leaves, 18-20.
Sheath (part of leaf), 17.
Shoot, small branch in its first year's growth from a bud, 7.
Shrub, a woody perennial plant, often much branched, and not reaching above 10 or 12 feet in height, 2.
Silicle, the short and broad form of siliqua, 55, 75.
Siliqua, a form of fruit, 55, 75.
Simple leaves, 14.
Sinuate anthers, 40.
Skin of ovule, 52.
Skin of seed, 58, 59.
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Spadix, fleshy axis of an inflorescence, 25.
Spike, form of inflorescence with sessile flowers, 25.
Spikelet, a minute spike, with few flowers, 90, 91.
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Spurred sepal, 31.
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WHORL, assemblage of members attached at one level to an axis, 17, 25, 30, 42.
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Printed by R. & R. CLARK *Edinburgh.*